The Engineer.

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[Vol. CXXIV.—No. 3210] LONDON: FRIDAY EVENING, JULY 6, 1917. [Price Eightpence By Inland Post Tenpence

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REQUIRED for the Gold Coast Government Railway, for two tours of twelve months' service, with possible extension. Salary, £350-£10-£400 per annum. Free quarters and first-class passages. Liberal leave in England on full salary.—Candidates who are capable Mechanical Draughtsmen, having sound technical knowledge of Locomotives and Machinery, and ability to instruct and deliver lectures to apprentices, &c., should apply at once (by letter) to the CROWN AGENTS for the COLONIES, 4, Millbank, London, S.W. 1. Men engaged on Government work, or eligible for the Army, will not be considered. 54

PATENTS AND DESIGNS ACTS, 1907-1914.
GELATINE EXPLOSIVES.

The Proprietor of British Letters

Patent No. 17,205 of 1913 is prepared to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to an explosive constituted by mixing oxidising salts with a gelatine formed by dissolving collodion cotton in a liquid nitrate of toluene of a certain class.
Address: BOULT, WADE and TENNANT, 111 and 112, Hatton-garden, London, E.C. 1.
80 r

The University of Liverpool.—

SESSION 1916-17 LENT TERM BEGINS ON 9th JANUARY.

FACULTY OF ENGINEERING.
Dean—J. WEMYSS ANDERSON, M.Eng. M.Inst. C.E.
Professors and Lecturers.

ENGINEERING: Harrison Professor—W. H. Watkinson, M.Eng., M. Inst. C.E., M.I. Mech. E., M.I.E.E.
Lecturer in Strength of Materials, W. Mason, D.Sc, Assoc. M. Inst. C.E.
ELECTRICAL ENGINEERING: David Jardine Professor.—E. W. Marchant, D.Sc., M.I.E.E.
Lecturer in Municipal Electrical Engineering.—Associate Professor A. Bromley Holmes, M.Eng., M.Inst.C.E., M.I.E.E.
CIVIL ENGINEERING: Professor S. W. Perrott, M.A.I., M.Inst. C.E.
Lecturer in Railway Engineering.—Associate Professor J. A. F. Aspinall, M.Eng., M.Inst.C.E., M.I. Mech.E.
Lecturer in Municipal Engineering.—Associate Professor J. A. Brodie, M.Eng., M.Inst.C.E., M.I.Mech.E.
Lecturer in Dock and Harbour Engineering.—Associate Professor A. G. Lyster, M.Eng., P.Inst.C.E.
Lecturer in Engineering Geology.—J. Vincent Elsden, D.Sc., F.G.S.
Lecturer in Dock and Harbour Construction.—T. R. Wilton, M.A., Assoc. M.Inst.C.E.
NAVAL ARCHITECTURE: Alexander Elder Professor—Professor T. B. Abell, M.Eng., R.C.N.C., ret., M.Inst.N.A.
MARINE ENGINEERING: Professors and Lecturers in Naval Architecture and Engineering.
DESIGN AND DRAWING AND REFRIGERATION: Lecturer—J. Wemyss Anderson, M.Eng., M. Inst. C.E., M.I. Mech. E.
MATHEMATICS: Professor F. S. Carey, M.A.
PHYSICS: Lyon Jones Professor—L. R. Wilberforce, M.A.
CHEMISTRY: Grant Professor—E. C. C. Baly, M.Sc., F.R.S., F.I.C.

The Special Matriculation Examination, or the Entrance Examination, must be passed to secure admission to courses of instruction in the Faculty.
The Prospectus of the Faculty may be obtained on application to the undersigned.
EDWARD CAREY
Registrar.

THE MANCHESTER MUNICIPAL
SCHOOL OF TECHNOLOGY
(UNIVERSITY OF MANCHESTER)

Principal: J. C. M. Garnett, M.A. (late Fellow of Trinity College, Cambridge).

The Session 1917-1918 will open on 5th October. Matriculation and Entrance Examinations will be held in July and September.
The Prospectus, forwarded free on application, gives particulars of the courses leading to the Manchester University degrees in the Faculty of Technology, and of the provision for Advanced Study and Research in the following departments:—
MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING,
SANITARY ENGINEERING (including Municipal Engineering),
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Bleaching, Dyeing and Dyestuff Manufacture, Printing, Papermaking, Brewing, and Metallurgy),
THE TEXTILE INDUSTRIES,
PRINTING AND PHOTOGRAPHIC TECHNOLOGY.
MINING,
ARCHITECTURE.
Intending students may enrol for the Session 1917-18 from 1st August, 1917. Members of the University under 18 years of age are eligible for membership of the Officers' Training Corps. 793 r

University College, Nottingham.

DEPARTMENT OF ENGINEERING.

A LECTURER in ELECTRICAL ENGINEERING is REQUIRED to commence work in September. The appointment will be for the duration of the war, and will be reviewed on its termination.
Full particulars concerning salary, &c., and forms of application, may be obtained from
J. E. SHIMELD,
839 Acting Registrar.

Wigan and District Mining and

TECHNICAL COLLEGE.
APPLICATIONS are invited for the POSITION of ENGINEERING LECTURER for Day and Evening Classes.
Salary, £150, rising by £10 annually to £180, together with war bonus of 10 per cent.
Further particulars can be obtained from the undersigned, to whom applications should be sent before July 14th.
S. C. LAWS, M.A., B.Sc.,
Principal.
June 22nd, 1917. 800

South Staffordshire Waterworks

COMPANY.
Applications are invited for the position of CHIEF ENGINEER of the above Company. Applicants are requested to state previous experience and to send copies of testimonials to the SECRETARY, at the Office of the Company, Paradise-street, Birmingham, not later than 21st July, 1917. 83

The Clayton Aniline Company,

LIMITED, MANCHESTER.
RAILWAYS.—CONTRACT No. 3.
The Directors of the Clayton Aniline Company, Ltd., are prepared to receive TENDERS for the WORKS included in the above contract.
The works comprise the Reinforced Concrete Girders and Decking and the Brickwork Parapets, &c., for the Viaducts.
The drawings of the viaducts may be inspected and copies of the specification, bill of quantities, and form of Tender may be obtained at the office of Mr. J. A. Orrell, A.M. Inst.C.E., 42, Spring-gardens, Manchester, on and after Tuesday, the 10th inst., on the payment of the sum of £2 2s., which will be returned on receipt of a *bond fide* Tender.
The Tenders are to be enclosed in sealed envelopes, endorsed "Tender for Railways, Contract No. 3," and addressed to the SECRETARY, the Clayton Aniline Company, Limited, Manchester. The Tenders should be delivered at the Clayton Aniline Company's principal office before 10 a.m. on Monday, July 23rd, 1917. P770

The Maldens and Coombe Urban

DISTRICT COUNCIL.
WANTED at Once, MECHANICAL ENGINEER (temporary), with thorough knowledge of Diesel Oil Engines, Gas Engines, and Pumping Machinery.
Preference given to man with some experience in sewage treatment. Must be ineligible for Military Service.
Apply, stating salary, age, and full experience, to the SURVEYOR, Council Offices, New Malden, Surrey.
13th June, 1917. 73 A

Swansea Harbour Trust.

SALE OF HYDRAULIC CRANE.
The Trustees have for SALE a Second-hand 30-cwt. HYDRAULIC CRANE, now at the Prince of Wales Dock, Swansea. Full particulars may be obtained on application to the Engineer at the Harbour Office.
Tenders, sealed and marked "Tender for Crane," to be delivered to the undersigned on or before the 18th proximo.
The Trustees do not bind themselves to accept the highest or any Tender.
TAFOURD STRICK,
Clerk to the Trustees.
Harbour Offices, Swansea, 30th June, 1917. 52 s

Wanted, a Blast Furnace Man-

AGER to Take Charge of one or two Furnaces (Basic Iron).—Address, stating age, experience and salary required to 809, "The Engineer" Office. 809 A

Wanted, by Controlled Firm,

WORKS MANAGER with good all-round knowledge of Engineering Trade and up-to-date methods. Must be 6 o'clock man. Give particulars of experience, age and salary required. No person employed on Government work will be engaged.—Apply to nearest Employment Exchange, quoting "The Engineer" and number 72. 72 A

Wanted Immediately a Resident

ASSISTANT ENGINEER; must have Mechanical and Electrical experience.—Applications by letter, with copies of recent testimonials, should be addressed to the SECRETARY-SUPERINTENDENT, The Middlesex Hospital, London, W. 1. P785 A

Wanted, Man to Take Charge

of ELECTRICAL PLANT, Wiring, &c., in large Engineering Works in Eastern Counties. State age, experience, and wages required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3380. 75 A

Assistant Engineer Wanted

with Electrical and Mechanical experience to take charge of eight-hour shift in small Munition Works. Must be resourceful, strict timekeeper and rigid disciplinarian. Any person already on Government work will not be engaged.—Address, stating experience and salary required, 853, "The Engineer" Office. 853 A

Chief Mechanical Inspector

WANTED for large Works in the Midlands, one capable of taking entire charge of an output of from £5,0,0,000 to £10,000,000 per annum. Applicants must have had a thorough training in modern shop practice of an accurate nature and sound experience of general inspection. Salary £1000 a year. Applications, giving full details of training, experience, age, and complete addresses for references, to 805, "The Engineer" Office. 805 A

Engineer Required with Know-

LEDGE of Manufacturing Organisation and Production, and with full experience in the intelligent use of machine tools.—Address, with brief particulars of experience and salary required, to 69, "The Engineer" Office. 69 A

First-class Experienced Esti-

MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 695. 695 A

Inspectors (Skilled) for Aero-

PLANE Engine Work, &c. No person already engaged on Government work eligible.—Apply, stating full particulars, to your nearest Employment Exchange, and quote reference No A3333. 798 A

Machine Tool Business in Russia.

An important firm of Machine Tool Manufacturers, who are about to establish themselves in Russia, REQUIRE the SERVICES of a sound BUSINESS MAN of the highest qualifications, as RUSSIAN MANAGER, with the probability of a seat on the board. Applications will be considered from those who, owing to present engagements, are not able to take up duties immediately.—Address, 43, "The Engineer" Office. 43 A

Young Engineer, with Workshop

Training and Science Degree, WANTED for technical work in large Instrument-making Factory. No one engaged on Government munition work or eligible for military service should apply. State age, experience, and salary required.—Apply to nearest Employment Exchange, quoting "The Engineer" and number 81. 81 A

Wanted, by a Large Iron and

Steel Works owning Collieries, a thoroughly competent COST ACCOUNTANT. Must have had previous experience in up-to-date Factory Accounting. Qualified man preferred. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 91. 91 A

Chemist (Works), Used to Gen-

ERAL Metallurgical Analysis. No person already engaged on Government work eligible.—Apply, stating full particulars to your nearest Employment Exchange, quoting "The Engineer" and reference No A3336. 808 A

Wanted, Experienced Woman

TRACER, to take Charge of Tracing Department in Admiralty Drawing-office near Rochester.—Address, stating age, experience and salary required, P765, "The Engineer" Office. P765 A

Wanted, Several First-class

MECHANICAL DRAUGHTSMEN with good all-round experience for Admiralty work.—Apply (by letter only), stating age, experience, and present salary, to Box No. 1154, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C.4. 815 A

Chief Lady Tracer Required to

Take Charge of small Tracing Department on Government work in South of England. Only those who have had charge of a Tracing Staff for at least one year need apply.—State age, experience, present salary, and, if possible, send sample of work, to Box No. 1146, c.o. Messrs. R. F. White and Son, Genl. Advng. Agents, 33, Fleet-street, E.C. 4. 816 A

Draughtsman for Small Electri-

CAL Work REQUIRED immediately by a large firm of Electrical Engineers in West London, under Government control. State experience, age, and salary required. Those already on Government work, and residing more than ten miles distant, need not apply.—Address, 818, "The Engineer" Office. 818 A

Draughtsman, Junior, Mechan-

ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234. 492 A

Draughtsman Used to Graphical

work and general shop problems. No person already engaged on Government work eligible.—Apply, stating full particulars to your nearest Employment Exchange, quoting reference No. A3335. 797 A

Draughtsman with General Ex-

PERIENCE REQUIRED for Mechanical Engineer's office in large Munition Factory at Coventry.—State experience, age, and salary required to your nearest Employment Exchange, quoting "The Engineer" and No. A3147. No person already on Government work will be engaged. 49 A

Draughtsmen.—Some Experi-

ENCE in Crane Work essential. Both junior and senior men required. London District. Applicants must state age, past experience, and salary required. No person at present employed on War work will be engaged.—Apply to nearest Employment Exchange, quoting "The Engineer" and number 50. 50 A

Draughtsmen Wanted, Tho-

ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 670 A

Draughtsmen Wanted by Engi-

NEERING Firm for most urgent work in connection with Shipbuilding. Applicants must have had experience of marine engines or turbines for propelling purposes. Only those not on Government work considered.—State age, experience, and salary required to your nearest Employment Exchange, quoting "The Engineer" and number 644. 844 A

Draughtsmen Who Are Experi-

ENCED in the Lay Out of Power Stations (municipal and industrial) are REQUIRED by a large firm of mechanical and general engineers in the North. Those already engaged on Government work cannot be considered.—Apply, stating experience, salary, age, &c., to your nearest Employment Exchange, quoting "The Engineer" and number 843. 843 A

Mechanical Draughtsman, In-

ELIGIBLE REQUIRED in Consulting Engineer's office in the West Midlands; one used to hydraulic work and machinery similar to rubber machines. No person employed on Government work will be engaged.—Write, 63, "The Engineer" Office. 63 A

Mechanical Draughtsman Re-

QUIRED for Works Engineering Department of a large factory near London. Good experience in boiler-house and power plant lay-out, as well as some knowledge of building construction essential. Permanent position for suitable applicant. No one a ready engaged on Government work or residing more than 10 miles away need apply.
Write, stating age, salary, and full details of experience, to Box 113, c.o. Mitchell's Advertising Agency, 1, Snow-hill, E.C. 1. P786 B

Mechanical Draughtsman Re-

QUIRED for Works Engineering Department of a Large Factory near London. Some knowledge of Building Construction essential. Permanent position for suitable man.—No one already engaged on Government work, or residing more than ten miles away, need apply, stating age, salary, and full details of experience, to Box 105, c.o. Mitchell's Advertising Agency, 1, Snow-hill, E.C. 1. 819 A

Mechanical Draughtsman

WANTED IMMEDIATELY for a Government controlled establishment in South-West of England. Aircraft experience desirable but not essential. No person already on Government work will be engaged.—Apply, giving full particulars as to training, age, salary required, to your nearest Employment Exchange, mentioning No A3342. 802 A

Required Immediately for Con-

TROLLED Engineering Works, S.E. London:—
DRAUGHTSMAN (mechanical or marine),
Do. (with knowledge of estimating weights of castings).
DRAWING OFFICE CLEANER (1 male; 1 female).
Junior applicants must have had several years' experience. No applicants residing outside radius of 10 miles or already employed on Government work can be engaged.—Write, stating age, experience, and salary required, to 795, "The Engineer" Office. 795 A

Several Lady Tracers Required

for South of England, accustomed to high-class engineering work. Apply (by letter only), stating age, experience, present salary, and if possible enclose sample of work, to Box No. 1150, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C. 4. 814 A

Turbines.—Draughtsmen

WANTED, by large Firm in North of England, who have had experience in Turbine Design. JUNIORS also REQUIRED. No person already engaged on Government work can be considered. Positions permanent.—Apply, stating age and salary required, to your nearest Employment Exchange, quoting "The Engineer" and number 842. 842 A

Two Experienced Mechanical

DRAUGHTSMEN, preferably with knowledge of internal combustion engine work, but not absolutely essential. Prospects good but not merely for duration of war. Applicants must be ineligible for military service. Government work. London district.
No person already employed upon Government work will be engaged.
Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P746. P746 A

Wanted for Large Engineering

Works in Midlands, FOREMAN for Brass Turning and Finishing Department; must be conversant with modern plant and repetition work. State age, experience, and remuneration required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3367. 76 A

First-class Machine Shop Fore-

MAN, well up in high-class Repetition work on small Capstans and Automatics. Government Controlled Establishment. West London District. Preference given to one who has held similar position before the War. No man at present engaged on Government work or resident more than 10 miles away need apply.—Write, stating age, experience and salary for permanent job, to 817, "The Engineer" Office. 817 A

Wanted for Controlled Works

in London, experienced BORERS, TURNERS, DRILLERS, VERTICAL and HORIZONTAL MILLERS, and TOOLSMITHS. No one already on Government work can be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3381. P780 A

Working Electrician Wanted to

take charge of small Power House. High pay for excellent man.—JARDINE, Nottingham. 48 A

Acetylene Welder Wanted by

large Company, Birmingham district, engaged on most important Munitions work. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3379. 58 A

Hardener (High Speed Steel)

WANTED for most important Munitions work. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3378. 57 A

Iron Warehouseman Required,

strong, with thorough experience of Engineers' and Smiths' requirements. Wage 35s.—Apply by letter, stating age and experience, to LANKESTER and SON, Ltd., Iron and Steel Merchants, Southampton. 70 A

Jigmakers and Cutter Filers.—

Three of each REQUIRED by a Company engaged on important War Munitions. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3377. 56 A

Toolmaker Wanted by General

Engineering Firm. The applicant should be able to get out his own tools and see to their use; he should be capable of working up to position of foreman or occupying same at once, according to ability. Job a permanency to a suitable man. No one already on Government work will be engaged.—Write or call at nearest Employment Exchange, and quote "The Engineer" and number 65. 65 A

Chief Inspector, M.I. Mech.E.,

&c., 36, holding responsible position in Government controlled fac ory (20,000 hands) DESIRES CHANGE. Wide experience home and abroad, fully conversant aero and motor engines, guns, and shell of all sizes. Capable of dealing with large output.—Address, P762, "The Engineer" Office. P762 B

Civil Engineer (Ineligible) Re-

QUIRES POSITION. Many years' experience in office and on works, on railways, bridges, warehouses, &c. Good surveyor and draughtsman. Calculations and quantities. Will go abroad.—Address, P772, "The Engineer" Office. P772 B

Constructional and Inspecting

ENGINEER DESIRES APPOINTMENT in Light or Heavy Structional Steel work. Sinking caissons, cylinders, screw-piles, and other construction work. Wide experience and highest references.—F. D., Rock Cottage, Market Drayton. P769 B

Designer (28), B.Sc. (Hons.),

A.M.I.C.E., SHORTLY OPEN for ENGAGEMENT. Sound general mechanical experience, works, D.O., commercial, literary; ineligible.—Address, P767, "The Engineer" Office. P767 B

Engineer, Mechanical, Chemical,

Carboniising, large experience design, construction, working, commercial, finance and patent work, now managing director, REQUIRES POSITION of responsibility. Highest credentials.—Address, P768, "The Engineer" Office. P768 B

Experienced Practical and Tech-

NICAL Engineer, over military age, SEEKS POST. Home or abroad. Erection, economical running steam, Diesel, electric plants, gearing, &c.; excellent refs. and testimonials.—Address, P788, "The Engineer" Office. P788 B

Foundry Manager or Shop Fore-

MAN.—Advertiser DESIRES SITUATION as either; ineligible and disengaged; thoroughly conversant with all branches of the trade; certificated metallurgist; 32 years' excellent references; London district preferred.—F. G. S., 42, Alexandra-road, Hemel Hempstead. P769 B

Mechanical Engineer, Russian,

trained at French University, used to motor car, aeroplane, and gun work, speaking Russian, English, and French, WANTS SITUATION. Government work only considered.—Address, P761, "The Engineer" Office P761 B

Position Required, Permanent or

occasional, experienced in internal combustion engines, steam and general engineering, designing, making, repairs, managing, travelling, speciality semi-Diesels, home and Swedish experience. Over military age.—Address, P771, "The Engineer" Office. P771 B

Practical Engineer (45), Large

experience of boilers, marine engines, mill machinery, contractors' plant, motors, gas engines, portable engines, &c., DESIRES POSITION as TRAVELLER or AGENCY for the above.—Address, P773, "The Engineer" Office. P773 B

Supervisor Disengaged; has 16

years practical and technical engineering training. Well up in modern methods of production, piecework, &c. Used to organising and controlling all classes of labour.—Address P764, "The Engineer" Office. P764 B

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26, Collingwood-street, Newcastle-on-Tyne. 4p 3008

SMALL ADVERTISEMENTS

SITUATIONS, FOR SALE, &c.,
Pages II., III., LXXXVIII.

Numerical Index to Advertisements, Page LXXXVII.

Structural Engineer. — Experienced designer and detailer, many years' experience in responsible post, all classes structural work; bridges, buildings, cranes, shipyard equipment, civil engineering; thoroughly reliable, able to control staff; DESIRES APPOINTMENT.—Address, 74, "The Engineer" Office. 74 z

Accountant (Lady) Desires POSITION as Secretary or Chief Clerk to an Engineer. Expert shorthand-typist and tracer. Excellent references.—Address, 68, "The Engineer" Office. 68 z

Designer and Draughtsman in London REQUIRES Spare Time EMPLOYMENT. Power schemes, engine and machinery design, and constructional work. Wide technical knowledge.—Address, P776, "The Engineer" Office. P776 z

Lady Tracer Requires Spare Time TRACING. Reasonable terms.—Address, P775, "The Engineer" Office. P775 z

Tracing Wanted, as Spare Time work, by competent Draughtsman.—Apply, by letter, to P765, "The Engineer" Office. P765 z

Iron and Brass Foundry Fore- MAN (Journeyman) SEEKS POSITION as above. Forty years' experience; engine and ordnance, in all branches, all metals, except steel.—Address P764, "The Engineer" Office. P764 z

Traveller in Touch for Selling Pig Iron, is DESIROUS of HEARING from a FIRM UNREPRESENTED for their Foundry Brands in either Lancashire, Cheshire, or Yorkshire.—Address, P763, "The Engineer" Office P763 z

Coppersmith and Sheet Metal WORKER (41), shortly disengaged, DESIRES POSITION of TRUST at home or abroad. Wide experience; aeroplanes, motor cars, locomotives, marine and general work; a good organiser, thorough disciplinarian, and used to the controlling large numbers.—Address, P774, "The Engineer" Office. P774 z

Ships' Plate Leveller Wants WORK (piece); used to T.B.D. and ste m pinnace levelling.—Address, P766, "The Engineer" Office. P766 z

A Large Firm of Engineers in the Midlands HAVE an OPENING for a YOUTH of Good Education as PREMIUM PUPIL, the course to include both Works and Drawing-office. Address, 2002, "The Engineer" Office 2002 z

Boy Wanted, with Aptitude for drawing and engineering, for Structural Engineer's Office. Age about 15.—Reply in writing, stating age and where educated, to BRAITHWAITE and CO., 117, Victoria-street, S.W. 1. 92 z

Inspecting Engineers, Estab- LISHED over 20 years in Midlands, with qualified staff can UNDERTAKE TESTING and SUPERVISION, Electrical Plant, Structural Work, Bridgework, Rolling Stock, Machinery &c.—Address, P236, "The Engineer" Office. P236 z

London Representation.—Adver- TISERS have had 15 years' experience in Railway Rolling Stock Supplies and Plant for Colonial and Foreign Railways. Acquainted with the leading consulting engineers' requirements. AGENCIES for Specialities of particular interest to railways and the export trade generally WANTED either immediately or later on.—Address in confidence, 6, "The Engineer" Office. 6 z

Steel and Tools.—Agent Re- QUIRED for Scotland and Ireland by first-class Steel firm.—Address, 55, "The Engineer" Office. 55 z

Wanted, Boring Mill, to Take 8ft. to 12ft. diamster. State makers, date, when new, and price.—Replies to 825, "The Engineer" Office. 825 z

Wanted, For Immediate Ship- MENT abroad, one or two large BOILERS (Tubular type preferred), new or second-hand, pressure not less than 120 lb. per sq in.—Tenders with full particulars to be sent to K. L. M., c.o. J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 67 z

Wanted, Immediate Delivery, 1300ft. of ROLLED JOISTS, 16in. × 6in. section (or equal), lengths of not less than 27ft., and like quantity of 9 lb. BRIDGE RAILS or equal section.—Address full particulars to 64, "The Engineer" Office. 64 z

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.R., Smith's Agency, Ltd., 100, Fleet-street, E.C 2 z

Generating Set Wanted, About 75/100 K.W. Must be in good condition, and by good maker.—Give full particulars, and state lowest price to ABBOTT and Co. (Newark), Ltd., Newark. 44 z

Power Plant Required; Good second-hand; guarantee or inspection certificates required; 15 B.H.P. steam engine, existing boiler 40 lb. pressure; alternative oil engine or town gas. Also 60 H.P. ENGINE and BOILER; combined plant preferred; must be modern type.—Write 216, Sell's Advertising Offices, Fleet-street, E.C. 4. 161 z

Bucket Dredge, Modern Manu- FACTURE, for SALE by Debenture Holders; fitted with 4 cu ft. buckets; digs 16ft. below water-line, stacks 10ft. above; steel hull of 3in. plates; 90ft. long, 30ft. wide, 6ft. deep; well hole in rear; fitted with suction gas engine; paid expenses on old sands yielding only 4½ oz. tin per cubic yard; easily converted for gold dredge; cost about £11,000; can be seen in England. Price £4000.—Apply, DEW, 8, Laurence Pountney-hill, London, E.C. 39 c

Crossley Gas Engine, 28 Nominal horse-power, Magneto Ignition, in good order, complete with Suction Gas Plant. Can be seen running.—Apply, COVENTRY SIMPLEX ENGINES, Ltd., Paynes-lane Works, Coventry. 47 c

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London, S.E. Telephone No. 978 Hop. 882 c

For Sale:—
LANCASHIRE BOILER, 30ft. by 9ft., insured 160 lb. pressure.
GALLOWAY TYPE BOILERS, 28ft. by 7ft. and 18ft. by 6ft.; will reinsure for 80 lb. pressure.
CORNISH BOILER, 10ft. by 4ft.; will reinsure for 80 lb. pressure.
50 B.H.P. NATIONAL GAS ENGINE, No. 17,451, "X" type, with Suction Plant.
32 B.H.P. TANGYE OIL ENGINE, No. 7934 B.
DIAGONAL STEAM WINCH, 5in. diameter cylinder, 10in. stroke, link reversing motion, double purchase.
STEAM ENGINE by Tangye, 11in. cylinder by 22in. stroke, fitted with Condenser and Pycell Governor.
WORTHINGTON DUPLEX STEAM PUMPS, 6in. by 4in. by 6in., 3in. by 2in. by 3in., 3in. by 1½in. by 3in.
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JULY 6, 1917.—VOL. CXXIV.

THE ENGINEER.

JUNE.

Reconstruction.

RECONSTRUCTION must be numbered amongst the "blessed" words, for in its new sense—the sense of the Reconstruction Committee—it means a tremendous lot, no less than the complete renaissance of the industries of the kingdom, and almost consequentially of the Empire. In this setting of our house in order the first step is to put capital and labour right, for the best schemes we can design will fall about our ears if labour troubles are to remain for ever a perpetual menace to development. In these circumstances it was a wise action of the general Reconstruction Committee to publish a few days ago an interim report by its Sub-committee, which has been entrusted with the problems of the employer and the employed. This Sub-committee, of which Mr. Whitley is the chairman, has ardent faith in conciliation. It believes that most industrial troubles can be overcome by a free discussion of the difficulties, and it proposes the establishment of permanent machinery that will bring representatives of employers and employed together at three different stages. Only in the last resort, if all else failed, would the Board of Trade intervene. The machinery consists first of Works Committees—periodical conferences between managers and their own workpeople for the discussion of domestic questions; secondly, of District Committees, on which local representatives of capital and labour would meet to discuss matters affecting districts; and thirdly, of a Standing National Council, which, as its name implies, would consider all the biggest issues. We are not quite clear whether these three bodies are to be regarded as successive courts of appeal, but they would in all probability become so in course of time. It is quite obvious that the success of a scheme of the kind hangs upon the completeness of the organisation of the employers on one side and the employed on the other. Unless the representatives are given plenary powers, and unless those powers are respected by the rank and file, no more can be achieved in the future by committees and councils than has been achieved in the past. The reporters, recognising this fact, urge the need of recognition of the trades unions, and the better organisation of the employers in all trades.

Munitions of War.

ON the twenty-eighth of the month Dr. Addison reviewed before the House of Commons the work of the Ministry of Munitions. His speech bristled with interesting points, and it is possible to indicate but a few here. Speaking of explosives, he told his hearers that the capacity for production was now four times as great as a year ago, and no less than twenty-eight times as great as in March, 1915. Of the adequacy of the output of shell admirable testimony is afforded by the statement that notwithstanding the enormous expenditure during the last few weeks the stock of filled shell has only been reduced by seven per cent. The quality, too, has improved, and the occurrence of premature bursts is now so rare as to be almost negligible. Railways are almost as important as ammunition, and it was interesting to hear that 2000 miles of track in a complete condition and over 1000 locomotives have been supplied to our armies. New forms of "tanks" are being rapidly developed, and the British Army is so well supplied with motor transport that it is able to help its Allies. Better organisation in aircraft construction has led to an "enormous increase" in the output. Touching upon the supply of munitions from overseas, Dr. Addison was able to make the comforting statement that the unrestricted submarine campaign has caused a loss of only 5.9 per cent. in shell consignments. It was satisfactory to learn also that the position with regard to steel supplies has greatly improved. The output of this country is now ten million tons per annum, as contrasted with seven million tons three years ago, and it is expected that twelve million tons will be reached by the end of next year—presumably the Parliamentary year which ends in March—for Dr. Addison looks forward to an increase of one and three-quarter million tons next spring, owing to the increase of the basic steel from home ores, to say nothing of acid steel. Finally, we may note that the Minister expressed satisfaction with the reduction in the cost of gun ammunition. He told the House that if the prices of the preceding year had been maintained the bill would have been forty-three million pounds more than it actually was.

The Shipbuilding Position.

THE more pressing needs of the immediate future for new ships will no doubt be met by the completion of the Government programme, which includes the reinforcement of the depleted mercantile marine by both construction and purchase. The complete restoration of the old supremacy of Great Britain in merchant shipping, which is an essential accompaniment of Empire progress, must, however, mainly depend upon private enterprise. It is satisfactory to know that our augmented shipbuilding resources are likely to be fully equal to the demand that will be made upon it, and that not only old centres of the industry, but new aspirants for a place in shipbuilding, of which the South Wales district is a conspicuous example, are making preparations for the rapid output of a large tonnage. Much, however, must depend upon the attitude of those who under ordinary circumstances would be disposed to embark capital in shipbuilding, and it is desirable that no action which would discourage the placing of contracts should be taken, or appear to be in contemplation, by the Government. It is obvious that those shipowners and others who place orders for new ships at war construction prices will, unless satisfactory financial guarantees are forthcoming, be left at no distant date with fleets which, from the play of natural causes, will have suffered considerable depreciation in value. The point was brought to the notice of the Government when Mr. McKenna was Chancellor of the Exchequer, and he gave a definite pledge that the difference in cost of ships built at war prices, and their ascertained peace value, should be recouped to shipowners out of their war earnings. It has been pointed out by the Shipowners' Parliamentary Committee in a memorandum issued on the last day of the month that Clause 19 of the Finance Act of 1917 will probably operate to deprive shipowners of this right, and unless this doubt can be cleared up there will be serious delay in the laying down of new ships. Another question which has in it the elements of controversy is the precise meaning which may be attached to the phrase "After the war," which has been used in connection with the determination of peace shipping values as against present cost. It seems desirable that a definite date should be fixed when the valuation would be made.

Aeronautical Events.

THE aeronautical activity of the past month maintained, if it did not surpass, the degree of intensity shown by its two immediate forerunners. During the night of May 31st–June 1st Royal Naval aircraft dropped many tons of bombs with good results on Ostend, Zeebrugge, and Bruges. The attacks were carried out in a series of raids from all of which our machines returned safely On the morning of the first, and again on the evening of the same day, the enemy's aerodrome at St. Denis Westrem and his bases at the three towns mentioned were once more attacked, several tons of explosives being dropped on them. On the night of the 3rd, Bruges dock and canal received the attention of the Dunkirk squadron. Soon after six on the evening of the 5th a squadron of about sixteen enemy aeroplanes attacked some small towns in Essex and the naval establishment in the river Medway. Negligible damage was caused to naval and military objects. Among the civil population, however, twelve people were killed, and thirty-six injured. It would appear that on the way across the enemy squadron was engaged by four of the naval machines from Dunkirk with indecisive results. On the return journey the enemy was engaged by naval aircraft from home stations and by ten naval machines from Dunkirk, with good results in each case. Altogether eight, or possibly ten, of the raiders were accounted for. On the night of the 3rd–4th the aerodrome at St. Denis Westrem, the enemy's seaplane base at Zeebrugge and the shipping at Bruges were attacked by our naval aircraft without loss to themselves. On the 4th one of our Dunkirk pilots attacked and drove down into the sea an enemy machine fifteen miles from land. On the night of the 4th–5th, and again at daybreak on the 5th, the hostile shipping in Bruges Harbour was attacked from the air. Many tons of bombs were dropped with good results. A hostile kite balloon was shot down by one of our machines during the course of this raid. All our pilots returned safely. On the 6th our naval aeroplanes attacked the enemy's aerodrome at Nieuwmunster, near the Belgium coast. Although attacked by hostile machines on the return journey, all our machines arrived back in safety. On the evening of the 6th naval pilots attacked and drove down three enemy machines near Dixmude. St. Denis Westrem was again bombed by naval machines—all of which returned safely—on the 9th.

Further Aeronautical Events.

AT 11.30 a.m. on the 13th a squadron of about fifteen enemy aeroplanes succeeded in reaching the East End of London, where numerous bombs were dropped. No damage of a naval or military nature was caused, but the casualties among the civil population, and especially among children, were high. According to the latest available figures 160 people lost their lives, while 430 received injuries. There are no grounds for supposing that the enemy's claim that all his machines returned safely is other than the truth. On the morning of the 14th Zeppelin L 43 was shot down in flames by British naval forces in the North Sea. An air raid, apparently of great intensity, was carried out on the morning of the 15th by naval machines against the enemy's aerodrome at St. Denis Westrem. None of our machines failed to return. Early in the morning of the 17th two enemy airships attempted to raid our coasts. One of these at 2 a.m. dropped six bombs in a Kentish coast town, killing three and injuring twenty people, and doing damage to many houses. At about the same time the other airship raided an East Anglian coast town without causing damage or casualties of any kind. She was heavily attacked by gunfire and driven off, probably in a damaged condition. After dropping further bombs in open places she was engaged by a pilot of the Royal Flying Corps and brought to earth in flames. By some strange chance three of her crew were rescued, and it is believed are alive to-day. This vessel, according to the Germans, was the Z 48. Near Roulers, on the 25th, three naval aeroplanes met and engaged ten enemy machines. A fight of sixteen minutes duration ensued, during which one of the enemy was

sent down in flames, and two others were driven down out of control. The three British machines finished their patrol and returned safely. The figures as to aeroplane losses reported in Sir Douglas Haig's communiqués continue to reveal the manner in which we maintain the upper hand in the air at the front. Thus the number of British machines reported as missing during the month reached eighty-one. The Germans, on the other hand, definitely lost through the action of the British forces 130 machines, while 101 other machines were driven down out of control. It may be noted that of the enemy's definite losses nine are claimed for our anti-aircraft gunners, who, in addition, also claim to have brought down out of control two other enemy machines.

Naval Incidents.

COMPARATIVELY few naval incidents are to be recorded in connection with the history of the war during June. The chief reported occurrence was a heavy bombardment of the enemy's naval base and workshops at Ostend, carried out by British naval forces in the early hours of the 5th, and a running fight at the same time between British light cruisers and destroyers, under Commodore Tyrwhitt, and six German destroyers from Zeebrugge. In the course of the latter fight, one of the enemy's vessels, the S20, was sunk by gun fire, and another severely damaged. In neither British force were there any casualties, nor did any British ship receive damage. Aerial photographic reconnaissance conducted over Ostend soon after our bombardment from the sea showed that the majority of the workshops had been either seriously injured or totally destroyed. In addition, the entrance gates to the dockyard basin, the wharf, the submarine shelter and a destroyer under repair were badly damaged, while several vessels appear to have been sunk. Later reconnaissance showed that all large shipping had been removed from the harbour, and that the place presented a deserted appearance. Early in the morning of the 11th one of our drifters, while on patrol duty, apparently in the neighbourhood of Dover, encountered and engaged a group of five enemy seaplanes. Two of these machines were destroyed, the pilots being made prisoners. The remaining three made good their escape. During the night of the 13th–14th, his Majesty's armed merchant cruiser Avenger was torpedoed and sunk in the North Sea. All her company was saved with the exception of one man killed by the explosion. This vessel was a twin-screwed geared turbine liner of about 15,000 tons. Originally named the Aotearoa, she was launched at Fairfield in June, 1915. She belonged to the Union Steamship Company of New Zealand. On the 18th our Admiralty announced that on the 2nd the British transport Cameronian had been torpedoed and sunk in the Eastern Mediterranean, with the loss of fifty-two lives among the troops on board and eleven of the ship's crew. This vessel belonged to the Leyland Line, and was built in Germany in 1913.

American Railway Rates.

As soon as the Supreme Court of the United States decided that the Adamson Act, making the trainmen's day eight hours instead of ten hours, was constitutional, the railway companies asked the Inter-state Commerce Commission for permission to increase their rates by 15 per cent. The Commission, appreciating the desirability of any increase coming into operation on July 1st, gave an early hearing to the case. The necessity for an increase was shown in the evidence given on behalf of the thirty-eight companies in the Eastern States by the general solicitor of the Pennsylvania Railroad. He said that if the proposed increase were granted, the additional revenue of these companies would be 158,000,000 dols. a year, whilst the increased expenses would be 235,000,000 dols. a year. The latter sum was made up of 77,000,000 dols. for additional wages, 68,000,000 dols. for the higher cost of fuel, and 89,000,000 dols. for increased cost of materials. On the basis of this estimate the net operating income would be 5.42 per cent. of the receipts, as compared with 5.53 per cent. in 1916. But should the advances in rates not be conceded the proportion would be only 3.12 per cent. On June 30th the Commission gave its decision, but, as yet, the exact wording is not known. Apparently only a small increase in all traffic rates has been conceded in the Eastern States, but none in the Southern and Western States. In all States the combined rail-and-water rates may be raised to the all-rail rates, and in all districts the rates for bitu minous coal, coke, and ore may be advanced 15 per cent., except those for ore in the Western States, which are not to be increased. Leave to apply again after October 29th was given. The Commission stated its opinion that the companies generally show substantial and increasing prosperity, and are in possession of ample reserves. It further expressed the view that the war would benefit the railroads rather than injure them.

Forth and Clyde Canal.

ALTHOUGH no official announcement on the subject has yet been made, those who are in touch with recent developments believe that naval considerations have led to a decision on the part of the Admiralty to construct a canal capable of receiving the largest warships between the Forth and the Clyde. The events of the war have indicated quite clearly the important uses to which such a waterway could be put, and it appears to be extremely probable that the construction work may be put in hand immediately after the termination of hostilities. Commercial interests are no less concerned than naval authorities in the realisation of this long cherished project. The Mid-Scotland Ship Canal National Association, which has taken an active part in the movement to bring about the construction of the canal, is, however, at issue with the Admiralty as to the route selected for the new waterway, and the difference of opinion is probably the prelude to a discussion of the merits of rival schemes. The Mid-Scotland Canal Association, which represents powerful commercial interests, has had plans prepared for a canal on the direct Glasgow-Forth route, which would enable the needs of important industries to be served. On the other hand, the Admiralty, for reasons which have not yet apparently been disclosed, is wedded to a canal which, having its western terminus at Loch Long, would be carried by way of Loch Lomond to the East Coast. Strong representations have, it is understood, been made to the Admiralty on the subject, and, as in view of the financial record of the Manchester Ship Canal, there is little hope that the Forth and Clyde Canal would be constructed without Government aid, it is hoped it may be possible to satisfy the views of naval experts without the disregard of the commercial aspect which is involved in the reported selection of the Loch Lomond route.

Co-operation in Industry.

UNDER ordinary circumstances the decision of a group of companies engaged in the same or allied branches of manufacture to carry out an amalgamation scheme would possess little interest outside financial circles. The times, however, are not ordinary; industry united for the first time in a common national effort is accepting, here with obvious reluctance, and there with the zeal of the convert, the doctrines of a new commercial faith. Manufacturers who have hitherto found their most formidable rivals not in foreign competitors, but in British houses engaged in the same branch of engineering, have realised in the stern school of war the gains which follow from a policy of co-operation rather than competition. One example of the application of the new principle in engineering production has been given by the machine-tool trade, in which a number of firms have made a working agreement between themselves, under the title of the Associated British Machine Tool Makers, Limited, that each shall specialise in certain classes of work. By this means not only will much of the old senseless competition be removed, but the concentration on specialities must inevitably lead to improvement in design and reduction in cost of manufacture. Hence both the machine-tool makers and the purchasers will benefit. Now the chemical industry is about to give practical expression to the joint manufacturing system. The amalgamation of interests between Messrs. Brunner, Mond and Co., and Messrs. Chance and Hunt, is to be followed by the union of a group of companies engaged in the manufacture of explosives. It is rather the reasons which underlie this tendency towards co-operation than the fact itself which is of interest to engineers. It arises, as the chairman of Nobel's Explosives Company stated at the last annual meeting, from the demonstration that the interchange of technical as well as administrative experience has a marked effect on quality, output, and cost of production. There had been attempts to bring about a manufacturing union in the explosives branch of the chemical trade in past years, but it apparently needed the blast of war to throw down the remaining barriers behind which secrecy in manufacture maintained its last stronghold. Proof has now been given that wisely directed effort planned on a common basis by those engaged in the same industry is the only policy which is likely to stand the searching tests which will be imposed in the new industrial era. The advantages of co-operation are shared by all concerned, labour, capital, and the consumer.

Two Railway Accident Reports.

Two reports to the Board of Trade on railway accidents were issued during June, both of which, although on minor mishaps, showed the evil of assuming that certain events had happened. The first of these reports related to a collision on February 22nd, at the Moorgate-street station of the Metropolitan Railway, where, on the "widened lines," a signal failed to go to danger behind a train that had entered the station. The movements of the signalman in the box in the rear were electrically controlled, so that the signal which failed had to be at danger behind a train before a second train could be sent forward. As the signal in question was not in its proper position, the signalman could not get the second train accepted; but, instead of ascertaining why this was so, he assumed that the electrical apparatus was out of order and he used his releasing key to unlock the instrument. The driver of the second train ran forward, and finding the signal "off," and not knowing that an irregularity prevailed, he proceeded and came into collision with another train. The second report was in connection with a collision on the Glasgow District Subway on April 28th. In this case a train was stopped in a tunnel, and a second train was waiting to leave the station in the rear. After waiting there a minute or so, the station official asked on the telephone why the delay was occurring, and got in reply a message which gave the idea that the line was clear. As the signal could not be lowered—for the simple reason that the arrival of the train at the next station was necessary to release the signal—the staff at the station in the rear presumed that the electrical apparatus had failed, and they let the second train go against the signal, with the result that a slight collision occurred. The moral to be learned from both these accidents is, that it is useless for railway companies to provide these safeguards if at the same time they give—as at Moorgate-street—a ready means of negativing them, or if—as in the second case—the regulations are not strictly observed.

The Future of Canadian Railways.

ON July 13th, 1916, the Committee of the Privy Council of Canada received a report that at the then recent Session of the Canadian Parliament it had been necessary to make provision for assistance by loan to the Grand Trunk Pacific and the Canadian Northern Railway Companies. As a result a Commission was appointed to investigate the general problem of railway transportation in Canada, and to make recommendations. Three experts were engaged to conduct the inquiry, and they have recently reported. Their recommendations are not unanimous. Two—Sir Henry Drayton and Mr. W. M. Acworth—suggest that the two railways named above, together with the Grand Trunk, the Intercolonial, and the National Transcontinental, should be taken over by a board of trustees, and that the lines should be worked on a commercial basis for the benefit of the people of Canada. The Canadian Pacific Railway, they think, should not be disturbed, as it can take care of itself. The minority report is by Mr. A. H. Smith, the president of the New York Central system. He recommends also that the Canadian Pacific be left alone, but proposes that the other lines should be so re-arranged that their working would be more profitable. He thinks, however, that the Government should take over some railways temporarily, and work them through a board of trustees. Mr. Smith makes this proposal in the belief that when the war is over Canada will resume her prosperous growth, but that in the meanwhile her railways need assistance. The majority report shows a decided opposition to State ownership and operation of railways, and on this account it recommends that the lines should be worked by a board of trustees as a commercial undertaking, whilst, because of the large amount of public money that has been invested in the railway system, it is argued that the benefit should go to the people. A certain amount of money from this and other countries outside Canada has been invested in the Grand Trunk, and it is proposed to meet this call by the payment of an annuity. Both reports, the majority and minority, are agreed that considerable sums should be spent forthwith on equipment.

THE LATENT HEAT OF STEAM.

By FRANK B. ASPINALL., M.I.E.E.

No. I.

WHEN practical and scientific steam history is examined, the outstanding feature is the extraordinary game of cross purposes which has been produced by the term "saturated steam," for no less than sixteen totally different definitions have been accepted at different times by different people. This, then, is the vital issue:—

Do all the values stated in the accepted steam tables for the total heat, the latent heat, and the volume apply to steam which is definitely, accurately and scientifically steam?

When one tries, however, to answer this definite question, this extraordinary fact appears. It has never been definitely agreed as to what constitutes steam, total heat, latent heat, heat latent, and a steam volume.

The following determinate definitions are therefore suggested:—

Steam is that which exists when absolutely no water and absolutely no superheat is present.

The Total Heat in Steam is the exact quantity of heat present when absolutely no water, and absolutely no superheat is present.

The Latent Heat of Steam is the exact quantity of heat required to convert water from the form of water completely into the form of steam, at the same temperature and pressure as the temperature and the pressure of the water converted into the steam.

Heat Latent is the varying heat latent when varying mixtures of steam and water are present.

A Steam Volume is the maximum volume which can be present without superheat being present.

If these definitions are accepted, then for steam tables to apply to steam which is definitely, accurately and scientifically steam, these fundamental conditions must be complied with:—

Every individual value stated for the total heat must be the maximum heat which can be present, without superheat being present.

Every individual value stated for the latent heat must be the maximum heat which can be latent.

Every individual value stated for the volume must be the maximum volume which can be present, without superheat being present.

Some years ago the author analysed hundreds of indicator cards to try and find the Missing Quantity, and facts were noticed which were unexplainable, unless steam at high pressures, containing absolutely no water and absolutely no superheat carried more heat, and had a smaller volume, than the steam tables stated. A series of measurements was therefore made to ascertain the maximum heat and the maximum volume which could be present, without superheat being present. This was the result:—

The maximum heat which could be latent, or the latent heat of steam, was found to be constant, at a value nearly, if not actually, of 970.13 B.Th.U.

A steam volume multiplied by a steam pressure is a constant, if steam is accepted as that which exists when absolutely no water, and absolutely no superheat is present, the value stated in cubic feet and lb absolute being nearly, if not actually 399.84.

From these two constants the following conclusions were arrived at in regard to the steam tables.

The values stated for the total heat at above atmospheric pressure apply to wet steam, the wetness increasing as the pressure increases.

The values stated for the total heat at below atmospheric pressure apply to superheated steam, the superheat increasing as the pressure decreases.

The values stated for the latent heat at above atmospheric pressure apply to the heat latent in mixtures of steam and water, the water increasing as the pressure increases.

The values stated for the latent heat at below atmospheric pressure apply to neither latent heat nor heat latent.

The values stated for the volumes at above 25 lb. abs. apply to superheated steam, the superheat increasing as the pressure increases.

The values stated for the volumes at below 25 lb. abs. apply to wet steam, the wetness increasing as the pressure decreases.

The values are therefore not only not comparable in themselves, but are also not comparable to each other. For instance—

At 160 lb. abs. the value stated for the total heat applies to wet steam; the value stated for the latent heat applies to the heat latent in a certain mixture of steam and water, and the value stated for the volume applies to superheated steam.

At 1 lb. abs. the value stated for the total heat applies to superheated steam; the value stated for the latent heat applies to neither latent heat nor heat latent, and the value stated for the volume applies to wet steam in a certain state of wetness.

The author then examined the original descriptions of the investigations made by Southern, James Watt, Carnot, Regnault and Fairbairn and Tate. This was the result:—

Southern accepted and measured latent heat as defined, and arrived at these two laws:—"The latent heat of steam is a constant." This is known as Southern's law. "The density of steam is nearly, if not actually, proportional to the pressure." If a small error in his manometer is corrected for, his results show that the density is proportional to the pressure. If one law is true, the other must be true. His results give the following values for the two constants—967.50, 398.97.

James Watt accepted latent heat as defined, but, unfortunately, altered one of his observed temperatures, for some reason not stated. If his observed temperature is accepted, his results show that the latent heat of steam is a constant, value 968.65. If his altered temperature is accepted, his results show that the total heat in steam is a constant. He expressed no opinion as to what his results proved.

Carnot accepted steam as that which exists when the change of form from water to steam is absolutely complete. What he declares to be "the fundamental basis of all heat engines" is true if latent heat, as defined, is a constant. Carnot flatly contradicts what are now known as the Carnot function and the Carnot cycle.

Regnault does not state what he accepted as steam and latent heat. He did not actually measure the heat latent in his steam, but arrived at it by deduction, after making certain assumptions. If his assumptions are accepted his method was quite legitimate. The accepted steam volumes were calculated from Regnault's empirical latent heat formula, the Carnot function, and Kelvin's mathematical assumption that there is an absolute zero temperature.

Fairbairn and Tate's object was to measure the density of steam at the point where superheating commences. They only considered V and not $P \times V$. Their values for V support the calculated volumes. Their values for $P \times V$ support the view:—

That $P \times V = 400.87$, a constant, if absolutely no water and no superheat is present.

That $P \times V$ is a variable, always more than the constant quantity, if superheat is present.

That $P \times V$ is a variable, always less than the constant quantity, if water is present.

The official tests of two condensers support the view that latent heat, as defined, is a constant value 969.71.

This then was the position;—

Regnault arrived at the latent heat by deduction, and found it to be a variable. Southern and the author accepted and measured latent heat, as defined, and found it to be a constant.

A series of letters, questioning Regnault, were then sent to THE ENGINEER, and a leading article appeared entitled "The Tyranny of Scientific Dogma." As the result of this leading article, the late Dr. Silvanus Thompson, F.R.S., read the original evidence, and advised that a new determination should be made to answer this definite question—

Is the heat latent a variable when water is present, and a constant when absolutely no water is present? This appeared to be the reason why Regnault obtained results which contradicted "Southern's Law," which was the accepted law when Regnault made his investigation.

Dr. Silvanus Thompson then kindly brought the matter before the City and Guilds of London Institution for Technical Education, which generously made a liberal grant to defray the cost of the determination.

The author then wrote a specification for the determination, and as no flaw could be detected when the proposed procedure was discussed by Dr. Thompson and the author, the author carried out the determination as specified at Finsbury Technical College, every facility and help being given by the College staff.

THE FINSBURY DETERMINATION.

The description of the investigation is arranged under four heads:

(1) The conditions to be fulfilled;
(2) The method and apparatus used;
(3) The observations and numerical results;
(4) Deductions arrived at.

THE CONDITIONS TO BE FULFILLED.

The following are the definitions adopted for the terms employed:—

The Latent Heat of Steam is the amount of heat required to convert water, at a definite temperature and pressure, completely into steam at the same temperature and pressure as the water.

The Sensible Heat in Steam is the heat in the water at the definite temperature and pressure at which it is converted into steam.

The Total Heat in Steam is the latent heat plus the sensible heat, or the maximum heat which can possibly be present without superheat being present.

Wet Steam is a mixture of steam and water in some form*. The total heat present is therefore less than that which would be present if the water had been completely converted into steam.

Steam is all steam, the total heat present being the exact amount required for all the water to be converted completely into steam.

Superheated Steam is all steam, the total heat present being more than the amount required at the given pressure and temperature for all water to be converted into steam.

Adopting these definitions it is an essential condition that at the place and at the time when the heat is measured, the steam shall be pure steam, neither superheated nor wet. This is not fulfilled by knowing accurately the temperature, or the pressure, nor even by knowing them both together, because that knowledge does not enable the actual state of the steam to be diagnosed. It is not sufficient to assume that the boiler produces pure steam, or even that the steam after passing through a separator is pure. It is essential that the state of the steam be definitely known at the place where the heat is measured. In this investigation this essential is fulfilled in the following way. To make sure that the steam is not wet it is just slightly superheated when it arrives at the point where the measurements are made, it being an easy matter to make a correction for the small amount of superheat thus permitted. So the process is to measure the total heat in the slightly superheated steam, and to deduct first the amount of superheat, and secondly, the amount of sensible heat, thus arriving at the latent heat. This procedure enables the condition of the steam to be known with certainty. So far as the author is aware, this method of arriving at the latent heat of steam is novel.

There is another consideration affecting the essential conditions to be observed during the research. In general, steam has air and other foreign matter mixed with it, affecting its density.

It is well known that condensers and jackets become air-logged, owing to air accumulating in them when steam is condensed; and such accumulation of air alters the conditions. The presence of air does not only imply that there is some heat present which is in the air and not in the steam. It implies something more; for as a little consideration will show it affects the quantity of heat in the steam. According to Dalton's law "the tension of the mixture of a gas and a vapour is equal to the sum of the tensions which each would possess if it occupied the same space alone." If, then, there is an accumulation of air, the apparent pressure as shown by the gauge is the sum of the air pressure and of the actual steam pressure; the actual steam pressure is less than that shown on the gauge; and is, in fact, the difference between the actual pressure of the mixture and the pressure that would be due to the air if all steam were withdrawn. It is vital that we should understand that the steam in the boiler may be pure steam, or it may be wet steam, and yet the mixture of steam and air, in equilibrium with the boiler steam and at the same temperature with it may be superheated steam because its true pressure, as above explained, is less than the apparent pressure. The steam mixed with air becomes, in fact, superheated by reason of the presence of the accumulated air just as truly as if it had been superheated by wire-drawing through a cock.

It is therefore absolutely essential to prevent air from accumulating at the point where the heat is measured, as it will cause the heat so measured to be less than that which would be present in pure steam at the observed pressure. It is even possible under certain conditions, with a mixture of air and steam, for the observed temperature and pressure to correspond to the temperature and pressure of pure steam at the observed pressure, and yet actually the steam present is all the while superheated steam at a lower pressure than the observed pressure. Every effort was therefore made to ensure that the heat which was measured, was measured in steam in which neither air nor water was present; that is the reason why in the procedure adopted the steam which came wet from the boiler was slightly superheated on its way to the point where the measurements were made, just sufficiently, in fact, to remove any chance of water affecting the result.

THE METHOD AND APPARATUS USED.

In choosing the method from a variety of possible processes, purely practical matters were carefully considered, and the arrangement finally adopted enabled the author to utilise ordinary commercial valves and pipework in setting up the apparatus.

To illustrate the general arrangement, elevation and plan skeleton diagrams are given herewith. In the elevation diagram the boiler has been turned round so that the front can be seen, but the true relative position of the condenser to the boiler is shown on the plan diagram. A sectional drawing of the calorimeter pipe work is also given.

The steam used in the trials was generated in a Yarrow water-tube boiler. A globular 1in. valve was placed in the main steam pipe just beyond the boiler stop valve, the steam being then taken by a 1in. pipe covered with 1in. lagging to the calorimeter stop valve. To this pipe was connected a Geipel trap. The diagram shows how the direction of the steam was altered to facilitate the removal of water. A fall in the pipe was given towards the trap both from the boiler and the calorimeter. The Geipel trap used was one of the special pattern made to act at all pressures and was used, not only to facilitate drainage, but to give warning if priming accidentally occurred. Provision was also made for passing the steam through the superheater if required.

When the steam had passed the calorimeter main stop valve, it could be passed either into the drain tub or into the pipe leading to the condensing water, or into both at the same time, by means of an adjust-

* These words, "in some form," require special explanation. It is usually held that the mixture of steam and water in a boiler is a mechanical mixture, the water being removable by a separator. But some of the measurements made in this investigation seem to involve the conclusion that steam, like air, can contain water in a state that no separator can remove mechanically.

ment of the controlling valves. The object of the drain-pipe was to remove any water which could not get to the trap or which got past the rise in the pipe where the trap was connected. It was also used to increase the flow of steam from the boiler, as, owing to the velocity of the steam being kept low in the pipe leading into the condensing water, it was very necessary to guard against radiation losses which might cause the steam to become wet after it had left the boiler, unless there was a good flow of steam in the pipe. The drain also served another purpose—to remove air from the boiler steam by blowing away steam and air before the trial started.†

Two thermometer wells and two pressure gauges were provided, so that the temperature and pressure of the steam could be accurately measured both before and after it entered the pipe leading to the condensing water. The arrangement also enabled the gauges and thermometers to be constantly checked, one against the other, to make certain that they agreed and did not alter during the trials.

Two different forms of pipe are illustrated, which could be connected to the flange; one of them could be turned up out of the condensing water by a swivelling joint, but the other could not. The reason why two pipes were used will be given later.

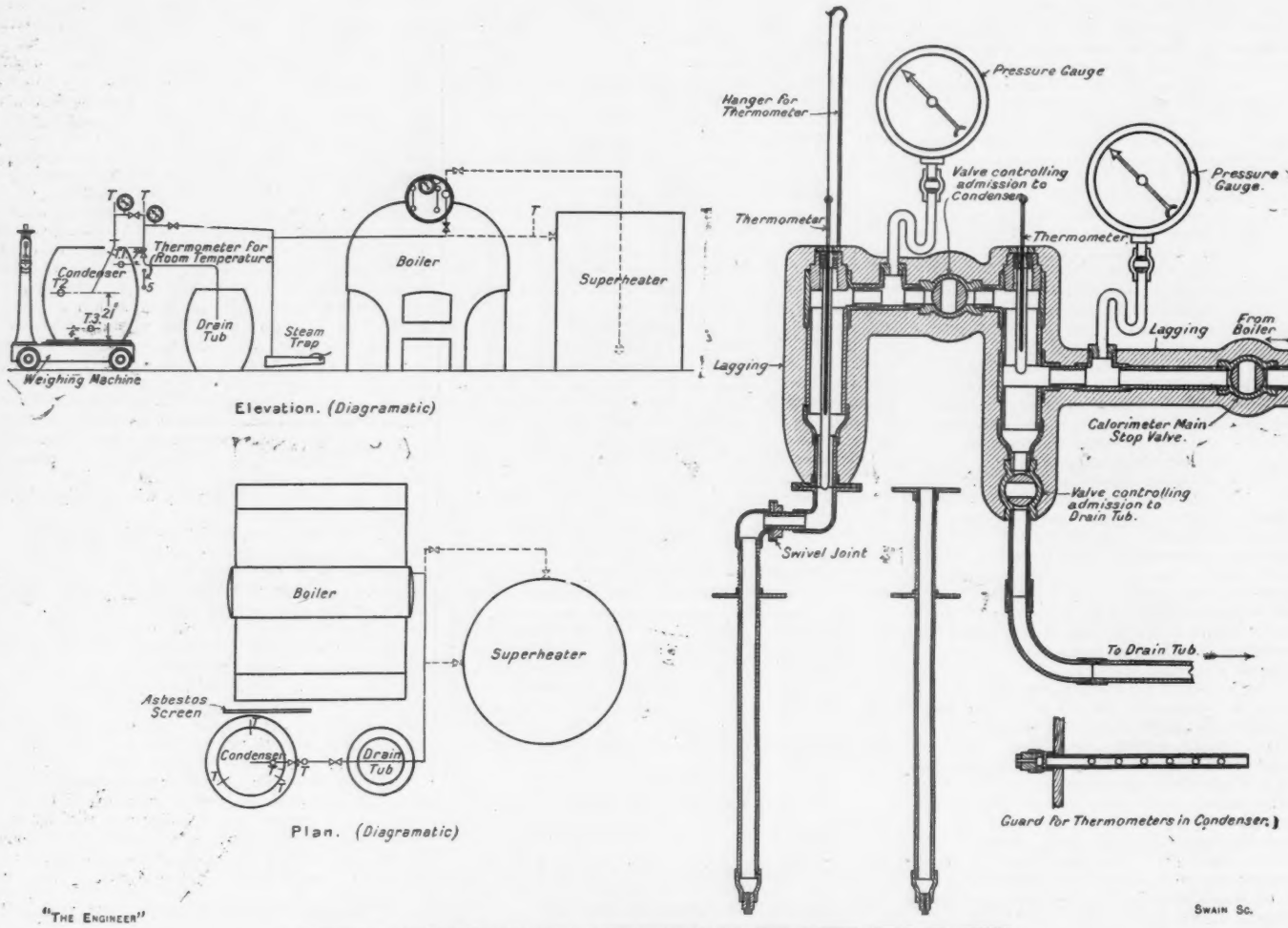
These pipes were screwed at the point where they entered the water, and a blank flange was screwed on to thermometer III., and thermometer II. was half-way on the circumference between thermometer I. and thermometer III. To ensure even greater certainty that the mean of these three thermometer readings gave the fair average temperature of the condensing water, they were not always read in the same order.

The thermometers were protected against breakage inside the barrel by pipes in which holes were drilled.

In the side of the barrel thermometer glands were placed, through which the thermometers were passed into the protecting pipes. The gland was formed by screwing a reducing socket on the guard pipe, a neck bushing being screwed into the socket before the pipe. A plug was placed in the large end of the reducing socket and a hole was drilled through the plug and neck bushing slightly larger than the thermometer. Two india-rubber gauge glass rings were placed between the bottom of the plug and the neck bushing. The thermometer, therefore, passed through the plug, the two rings and the neck bushing, and by tightening the plug just finger-tight, a water-tight joint could be made round the thermometer, and yet the thermometer could be either pushed into or withdrawn from the barrel at will. This gland, the design of Dr. Coker, was invaluable in enabling the author to read the thermometers accurately, and it was due to it that none of the thermometers were broken during the trials.

The steam pressure gauges used were specially made for these experiments by Messrs. Dewrance. Each division of the scale was marked after the pointer, which had a particularly fine point, had been brought to position by a dead weight. When completed, the gauges were tested again by the author to make certain that the marking had not been altered in finishing the scale. The ordinary divisions were 5 lb., but near 50 lb., 100 lb., and 150 lb., the divisions were 1 lb.; that is, the pressure could be read accurately from 45 lb. to 55 lb., 95 lb. to 105 lb., and 145 lb. to 155 lb. to a ¼ lb. on the other parts of the scale to 1 lb. These gauges were found to be very accurate, needing no corrections.

The thermometers were made by Messrs. Hicks, of Hatton-garden. Those by which the temperature of the steam was measured read up to 400 deg. Fah., each division of the scale being equal to one degree, and those for measuring the temperature of the condensing water read from 40 deg. Fah. to 110 deg. Fah., each division of the scale being equal to one-tenth of a degree, and these divisions were so wide that the temperature could be read with certainty to one-fortieth of a degree. The thermometers before use were sent to the National Physical Laboratory to be tested. The steam thermometers were tested at 302 deg., 338 deg., and 366 deg. Fah., and the condensing water thermometers



ASPINALL'S APPARATUS FOR THE DETERMINATION OF THE LATENT HEAT OF STEAM

so that it could be raised or lowered according to the height of the water. By providing more metal at this point, it prevented the water boiling where the pipe entered the water. Had this not been done, a considerable amount of heat would have escaped which ought to have gone into the water.

At the end of these pipes a reducing socket was placed, and in the socket a plug, which could be easily removed by a spanner. In the plug a hole was drilled, only 0.125in. in diameter. In all the trials, except two, the same plug was used, because it is the vital part of the whole apparatus. The drain-pipe leading into the drain tub also had a reducing socket at the end and a plug, but the hole in this plug was 0.25in. in diameter.

The condensing water was obtained from the coldest supply available, so that Rumford's Correction could be applied. The water was contained in a chestnut wood port barrel, as old wood well seasoned contains less water than a new barrel.

The temperature of the condensing water was taken by thermometer I. at the surface of the water, thermometer II. in the middle of the water, and thermometer III. 4in. from the bottom of the barrel. Thermometer I. was on the opposite side of the barrel

A barrel was used because its shape enabled the average temperature of the condensing water to be ascertained with great accuracy—the wood also reduced the radiation loss.

Between the barrel and the boiler an asbestos screen was placed so as to guard against heat being received from this source.

As there is always a difficulty in ascertaining the average temperature of metal, it was considered advisable to keep the weight of metal present as low as possible. The barrel was therefore filled with a hose and emptied by a syphon so as to avoid using a cock. The metal of the calorimeter from the main stop valve to the flange was covered with 1½in. of lagging. The area of the lagged pipe was .8 of a square foot, and the bare pipe .31 of a square foot.

The weighing machine used was specially supplied by Messrs. Avery, of Birmingham. It was so constructed, that it would weigh up to one ton accurately to within half an ounce. Before it was placed in position, the platform was levelled with a straight edge and level—the mean level being taken from corners to corners and sides to sides. Special precautions were taken to prevent an alteration of this levelling during the trials; when the machine was permanently fixed, it was tested with stamped weights and found to be correct within the above-mentioned limits.

every 5 deg., namely at 40 deg., 45 deg., 50 deg., &c. In correcting the actual readings, the error at the nearest tested temperature to the observed temperature, if any, was added or deducted as the case might be. The Fahrenheit scale was chosen because it enabled the difference of temperature to be ascertained with greater accuracy, as the difference of temperature of the condensing water is the most important factor in determining the latent heat of steam.

The pressures at which it was decided to measure the latent heat were 50 lb., 100 lb., and 150 lb. per square inch gauge, the latent heat being accepted as the quantity of heat required to convert water at a known temperature and pressure completely into steam at the same temperature and pressure as the water. To comply with this condition, it was accepted that the steam at the point where the heat was measured must be only steam at a super-temperature, but the super-temperature must be kept so low that, if possible, it should only represent one or two heat units more in the steam than the total heat which would have been in pure steam at the same pressure. If the steam is in this condition the total heat must be divided into superheat, sensible heat, and latent heat.

† The author now knows that it helped to remove free water from the boiler steam if free water existed.

PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT.

By GEORGE KENWORTHY, Asso. M. Inst. C.E.

No. I.

INTRODUCTION.

THE expression "Theory does not agree with Practice" is so often met that many practical men are almost led to believe that this is true. It is more correct to say that, where theory and practice disagree, it is due either to an imperfect understanding of the former, or through failure to carry out the necessary conditions underlying design in the latter.

It is proposed to deal in this article with the design and manufacture of structural steel work, and to discuss certain weaknesses in them, some of which will be found in most structures. The writer speaks from experience in the designer's office and in the workshop, enabling both points of view to be studied. Where workshop methods are mentioned they are general amongst the best British girder firms, and no particular one of them is being considered.

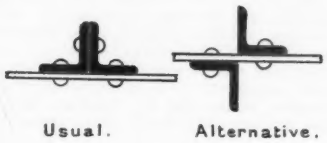


Fig. 1

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STIFFENERS FOR WEB PLATE GIRDERS

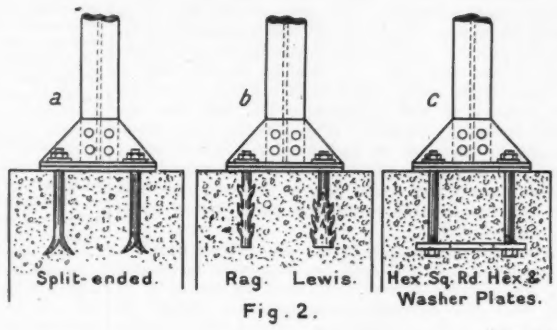


Fig. 2.

SWAIN Sc.

EXAMPLES OF HOLDING-DOWN BOLTS

It is hoped that by such an article as this engineers interested in this class of work may be led to enquire into the points raised, and take into consideration the factors introduced. It is not possible here to cite all the points which occur, nor even to treat exhaustively those which are raised; but the article will serve its purpose if those responsible for good work are shown the many doubtful practices in vogue, and warned to be on their guard against many others not noted. The article is divided into three sections, thus :—

(1) Mistaken assumptions in designing and drawing-office, in which it is shown that there are many weak features in roof design often neglected; that the permissible stress in rivets is often exceeded owing to an initial stress caused by contraction after cooling; that joints assumed to be butts are not so in fact, and that many instances occur of girders being designed as freely supported which are actually fixed ended, or perhaps continuous girders; and that the maximum stresses so caused are overlooked.

(2) Ways in which material may be used to better effect, or in which the nature and actual strength of material is not used to its best advantage. such as the neglect in manufacture of the "way of the grain."

(3) Oversights during manufacture which create in the finished structure serious initial stresses, such as may be caused by temperature changes during the period of marking, by the effects of cold straightening, by cold bending, by the elongation of bars due to punching, or by the effects of riveting.

SECTION I.—PART I.

WEAK FEATURES IN ROOF DESIGN.

Roofs and light buildings are generally supposed to be much stronger than they are actually required to be —in fact, if direct stresses are considered alone, it will often be found that the members of a roof truss can scarcely be made light enough. Some of the essential and yet simplest points to be considered are, however, often quite overlooked. For instance, the members of a roof truss are subject to bending, due to their own weight, and yet there are many important roofs which demonstrate that the designers have lost sight of this fact. A glaring example can be seen in a large railway goods shed in Birmingham, where the bottom tie of all the main trusses sags about ¾in.

The usual design for stiffeners to web plate girders, or for vertical posts and struts in lattice girders and roofs, is shown in Fig. 1. Alternatively is shown an arrangement by which exactly the same material is used in the design, and yet the radius of gyration is in the ratio of $\frac{1.5}{0.8} = 1.9$ times greater. The size of the angles shown for this calculation are 3in. by 3in. by ½in. It will be seen that it is often quite possible to arrange material in such a way that, even by using lighter bars, judiciously placed, the structure may yet be considerably stronger.

It will often be found too that, where a designer has cut down the scantlings of a roof very much, using perhaps gussets only ½in. thick, that the bearing stress of the rivets on the thin plates has been ignored, and that where the value of a ¾in. diameter rivet has been taken as 3 tons it has actually a value of only 1¾ tons. But in a light building, with little or no sway bracing, the most important thing perhaps is to have good foundation bolts in the concrete, by which the column is held rigid. There is a tendency to use H.D. bolts of an inferior type—see Fig. 2 (*a*); rag or lewis bolts without washers—Fig. 2 (*b*); proper bolts which are not long enough—Fig. 2 (*c*). Type (*a*) is practically no use. As soon as a pull comes on it, due to wind or whatever it might be, the split end closes, and the only resistance to pulling out is by the skin friction on the barrel of the bolt. Type (*b*) is better, but with ordinary builders' concrete neither the rag or lewis bolt is effective, as the only area acting against the concrete is the gross area over the rag minus the area of the bolt barrel. Such bolts are all right to prevent a machine moving horizontally, but should never be used in column bases. "Builders' concrete" is mentioned because in many instances of which the author has had knowledge, the concrete is little better than clotted sand. Long H.D. bolts of type "*c*" should be used with a flat washer plate between the bolts. The resistance of such a bolt set in concrete will then be fixed by half the area of the washer plate, and the depth to which it is set.

Architects, engineers, and contractors do not pay sufficient attention to foundations and the means of attachment to them, but the mere fact that bolts set in concrete cannot be examined as to type, length, or effectiveness by any critic, after a building is long completed, and when probably the drawings are not available, should be sufficient reason for insisting that they are correct in every feature. Wind bracing along the slope of a roof is necessary to prevent the whole number of principals collapsing like a pack of cards, and yet it is often entirely neglected. Owing to the collapse of a number of roofs a few years since, the Birmingham Corporation appointed an expert to examine such roofs as came within its area. It is probable that, putting aside bad workmanship, the cause was not to be found in the designs being too light, but that the structures were defective in certain of the features enumerated in this article.

INITIAL STRESS IN RIVETS.

Developing the stress of joints by means of a number of rivets taken at a certain safe shear stress on each rivet forms a very large part of girder design. It is intended to show here that the factor of safety in the rivets is far below what it is assumed to be. Consider a plate joint covered by two butt straps. The assumption is that each rivet will resist shear in the same way in which a round barrel—without any head or point—would do if it were tightly driven into the hole. This is not actually so. A large view of one rivet in the joint after it has sheared through is shown in Fig. 3.

d = diameter of shank in inches.
l = length of rivet in inches.
a = area of rivet barrel.
A = area of rivet head.
t = thickness of plate.
f = safe shear stress in tons.
b = safe bearing stress in tons.
s = tension in plate.
p = tension in rivet due to contraction in cooling.

Taking a rivet in double shear as one and three-quarters as strong as in one single shear, it would then be usual to take the strength of such a rivet as is shown above at the lesser value of $d \times t \times b$ tons, or $a \times f \times 1\frac{3}{4}$ tons. But the tension "p" is ignored. That such an initial tension exists, acting along the axis of all rivets which have had their heads driven down whilst hot—*i.e.*, rivets above ¾in. diameter—needs no proof, when it is remembered that, due to contraction in cooling, a tensile strain ensues, and, of course, a proportionate stress. Further, rivet heads have been known to fall off by simply tapping the plates, or, again, this stress may be traced in the ease with which rivet heads are sometimes cut off.

As combined stress actually takes place, which is found as follows, for a machine-snapped rivet—a hand rivet will give a different result, as is shown later :—

The temperature of rivet on leaving furnace = (about) 1800 deg. Fah.; the temperature immediately before snapping falls to (about) 1600 deg. Fah.; the temperature at the instant the jaws of the machine leave it = (about) 1000 deg. Fah.

Let E = the average modulus of elasticity during cooling. (If this was 13,400 tons at normal temperature, it may be taken as 10,000 tons at the temperature being considered, remembering that "E" falls steadily with increased temperature.)

x = the average coefficient of expansion per degree. (This may be taken as .0000062, knowing that increase of temperature above the normal in the early stage causes a drop in the elongation per degree, although later on elongation begins to rise steadily again.)*

Now, the strain on the rivet is caused by a drop of temperature in the rivet, not to normal temperature, but only to that temperature to which the surrounding material has risen owing to the presence of the rivet. It may be assumed that the plates round the rivet barrel rise to a temperature of 400 deg. at the instant before the rivet is closed. Immediately after closing, the cooling of the plates to normal temperature partly reduces whatever strain has previously been caused.

The strain due to drop in temperature from 1000 deg. Fah. to 400 deg. Fah.

$$= 600 \times \frac{x \times l}{l}.$$

The reduction in strain due to fall in temperature of plates to normal temperature (say, 50 deg. Fah.)

$$= (400 - 50) \times x.$$

Net effective strain $= (600 - 350)\, x = 250\, x$.

Then tensile stress produced = E strain.
$= E \times 250 \times x.$
$= 10{,}000 \times 250 \times .0000062.$
$= 15.5$ tons per square inch.

This stress is resolved into a compression under the neck of the rivet and a tension in the barrel, the former being in proportion to the latter, as the area under the neck is the area under the barrel.

For a rivet of 1in. diameter the overall diameter of the head = 1½in. $D = 1.5\, d$.

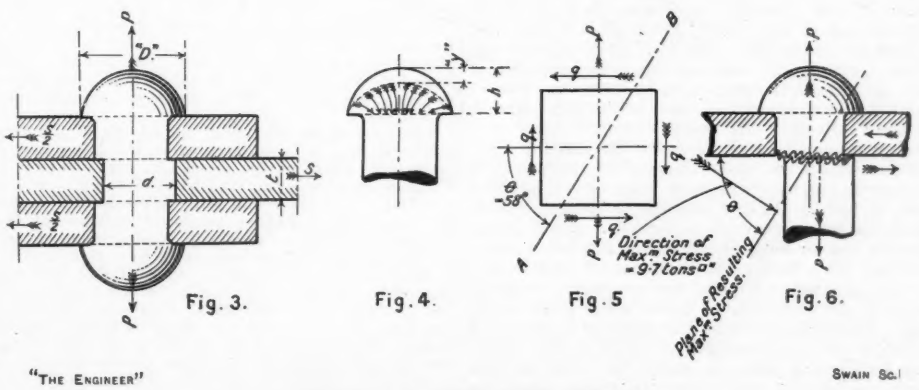


Fig. 3. Fig. 4. Fig. 5 Fig. 6.

"THE ENGINEER"

SWAIN Sc.

BEHAVIOUR OF RIVETS UNDER STRESS

(1) Then area of rivet head $= 2\frac{1}{4}\, d^2 \times .7854.$

(2) barrel $= d^2 \times .7854.$
under neck = (1) − (2) =
$1\frac{1}{4}\, d^2 \times .7854.$

$$\frac{\text{Compression on plate}}{\text{Tension in rivet}} = \frac{1\frac{1}{4}\, d^2\, .7854}{d^2\, .7854} = \frac{1\frac{1}{4}}{1} = \frac{5}{4}$$

Compression on plate $= \frac{15.5}{9} \times 5 = 8.6$ tons per square inch.

Tension in rivet $= \frac{15.5}{9} \times 4 = 6.9$ tons per square inch.

This tension will be somewhat further reduced by a very slight distortion of the rivet head—see Fig. 4.

If h = depth of head—say, ¼in.—and y = distor-

* Morley's "Strength of Materials."

tion in head due to tension of 6.9 tons per square inch,

$$y = \frac{h \times \text{stress}}{E} = \frac{5}{8} \times \frac{6.9}{10000} = .0004\text{in.},$$

which will reduce the strain in the rivet barrel accordingly, and consequently the effective stress of 6.9 tons.

Now, the total strain on the rivet barrel is proportional to its length, but the reduction of strain is a constant for any length of rivet. For trade lengths it may be taken that the strain and effective stress dependent on it is reduced by about 15 per cent.

Actual direct tension in rivet then = 6.9 − 15 per cent. of 6.9 = (say) 6 tons per square inch.

COMBINED SHEARING AND PULLING STRESSES.

Consider a small particle of the rivet material as shown in Fig. 5.

q = the shear per square inch.
p = the tension found above.
p_1 = resultant stress.
θ = angle at which p_1 acts.

Then $p_1 = \frac{1}{2} p \pm \sqrt{q^2 + \frac{1}{4} p^2}$, and

Tan $\theta = 1/q \left\{ \sqrt{q^2 + \frac{1}{4} p^2} - p/2 \right\}$ (Morley).

Taking the rivet under consideration as designed for a shear stress of 6 tons per square inch :—

$$p_1 = \tfrac{1}{2} \times 6 \pm \sqrt{6^2 + \tfrac{1}{4} \times 6^2} = 9.7.$$

$$\text{Tan } \theta = 1/6 \left\{ \sqrt{6^2 + \tfrac{1}{4} \times 6^2} - 6/2 \right\} = .616.$$

$$\theta = 58°.$$

No account is taken of friction between plates in above. Unwin assumes this to equal one-third the pressure between the plates. Whatever reduction in above "p_1" would follow on the reduced "q" is more than counterbalanced by the fact that the shear stress in rivets is usually a live stress, and alternates from about 6^T to 0, and is therefore twice the dead load stress. (This consideration is very generally overlooked.)

If a rivet were sheared through, owing to its shank being kept rigid, it would break through vertically, but the lines of cleavage would follow the plane of maximum stress. The annexed sketch—Fig. 6—is interesting as showing the probable—though exaggerated—way the rivet would shear through. Maximum stress in rivet = nearly 10 tons per square inch, acting along plane "A B."

Machine-driven rivets are usually heated in a built-up coal furnace to a temperature of nearly 2000 deg. Fah. In such a furnace 50 or 100 rivets may be put, in two tiers, preferably one above the other, so arranged that the supply is taken from the lower tier, whilst the "feed" is put in at the top. Thus those above are getting hot whilst the others down below are heated to their final heat, the upper rivets being pushed down a hole to be taken out ready in their turn. It is often thought that rivets are not heated all their length to the same temperature. This, though true with hand† rivets, is incorrect, as is perfectly obvious, in those heated as above. Rivets left in such a furnace too long will "scale." In fact, if riveters find the holes tight for their rivets, they will intentionally leave them in the furnace a longer time. Such overlong heating should be certainly prohibited in good work, as the nature of the rivet material is thus lost.

In a portable hand-riveting hearth only about three rivets are heated at one time, the head of the rivet being kept above the "breezes" and the point in the heart of the fire. For hand riveting the point of the rivet must be heated to an even greater heat than in machine riveting—say, to 2200 deg. Fah.—whilst the head is only at about 1600 deg. Herein lies the explanation of "burnt" rivets.

When a machine rivet is closed the uniform temperature allows the whole material in the barrel to be thickened up by the pressure, but not so if knocked down by hand. In this case the thickening follows where the temperature is higher—*i.e.*, at the point. For this reason long rivets, driven by hand, are a very bad job. One point in favour of hand rivets, however, is that the initial tension is not so great, owing to the succession of blows which play on the snap. These blows induce the material in the point to follow up the contracted material in the shank. This hammering goes on until the rivet is quite black, taking out, right until the finish, when the material is set, a good deal of the tension which, in a machine rivet, becomes permanent as soon as the jaws of the machine open out—the rivet then being at quite a red heat. The conclusions regarding riveting are then :—

(1) That the actually existing stress in rivets is perhaps as much as 66 per cent. in excess of that calculated on for machine work, but less for hand work.

(2) That this can be reduced somewhat by seeing that the rivets are not too hot when put into the work, that the pressure from the machine is kept on for a short time longer than is actually requisite for snapping, so that the machine will "follow up" the contraction—like the successive blows in hand work; or by the designer calculating for a lower shearing stress than is generally taken.

In considering the question of initial stress in rivets, a word should be said about the corresponding stress which is induced in bolts in tightening up. Bolted structures are becoming increasingly common, i.e., such parts as roof trusses, framing girders, wind bracing, &c., are sent loose from the works and bolted up permanently at site. Commerically this is sound practice, as, even in the works, it is often cheaper to put permanent bolts in than to first of all attach by service bolts, which are afterwards to be removed for rivets—whilst, at site, riveting plant and skilled riveters are dispensed with.

Now, "black bolts" cannot, and do not, of course, fill the holes in the same way as rivets driven in hot do. Then, in the finished structure, either the joints, gussets, or connections slip by the amount of the clearance in the holes, until the bolt takes up the shear, or else the bolts are so tightened up that the friction between the connecting surfaces is enough to resist the pull, without the shearing resistance of the bolts coming into play. If the former takes place, distortion of the structure is caused, and it must therefore be assumed that it is the friction between the surfaces which is the real strength of the connection. This strength depends on too many unknown quantities to be calculated. The unknowns are :—The coefficient of friction between the surfaces; the strength of the man who tightens up; the length of the spanner he uses, and the position of the bolt—whether it gives him good or bad purchase. It can be shown that a man may quite easily apply such a force at the end of a spanner as will so stress a ¾in. bolt that its elastic limit is passed. Undoubtedly this often happens in the case of the smaller sizes of bolts. When this has taken place the friction between the surfaces cannot be relied upon, nor can the bolt itself be expected to resist the shear stress when slip takes place.

Unwin draws attention to this axial stress in bolts, and points out that it may be, and often is, greater than the calculated load. At least 20 per cent. of bolts over the calculated requirements should be allowed in bolted structures, whilst the utmost vigilance should be maintained to see that the bolts are not tightened up above a reasonable amount.

† The term "Hand Rivets" used here and in other places is meant to include also rivets driven by pneumatic hammers.

TRAINING OF AERONAUTICAL ENGINEERS.

THERE can be no doubt about the success which has attended the series of papers and lectures which have been given this session under the auspices of the Aeronautical Society of Great Britain. An impetus has been given to the industry in many ways, and perhaps not least of all from the commercial point of view, which will tell its tale in the near future. On several occasions the regular meeting place, viz., the hall of the Royal Society of Arts, has proved too small, and on the occasion of the lecture by Mr. Holt Thomas on commercial aeronautics, the audience practically filled the large Central Hall, Westminster. Much the same may be said of the subsequent lecture on a similar subject by Lord Montagu, and the Wilbur Wright lecture by Colonel O'Gorman.

The session was wound up on Wednesday, June 27th, at the Royal Society of Arts, in a paper by Dr. R. Mullineux Walmsley and Mr. C. E. Luard, both of the Northampton Institute, on the "Training of Aeronautical Engineers." In these times one can hardly ascribe the small audience to lack of interest in technical education; possibly it was the hot weather which kept people away. Certainly the attendance was in strong contrast to many of the previous meetings in the same hall, and Dr. Walmsley had a tinge of sadness in his voice when he called attention to the fact, not surprising when one remembers the intense interest he takes in the subject. The paper, however, will not miss-fire on that account, and indeed it should not, for it is an attempt to lay down at the very beginning of a new industry a definite scheme of training.

Before, however, outlining the scheme of the paper, reference may be made to one point that assumed a prominent place in the discussion, viz., the fact that all third and fourth year students are being absorbed into the Army, with the result that, unless the State steps in, our engineering industries are in grave danger of being without an adequate supply of trained engineers when the war is over, and we have to set to work immediately to build up our trade again. Dr. Walmsley drew attention to the possibility as far back as 1915, in his paper before the Institution of Mechanical Engineers, but nothing has been done to check the draft on young engineers. Indeed, the position is far worse; so much so that he has, we understand, in the highest branches no third and fourth year students at all, and what this means for the future can easily be perceived. He pleaded that the State should try to preserve the normal quantity of students, say 3000 or 4000 for the higher technical institutions and universities, notwithstanding the indisputable demands of the Army and Navy. The point was not mentioned in the paper, and in replying to Mr. Henry Fowler, who raised it in the discussion, Dr. Walmsley gave the impression that he was almost without hope on the point, although his concern regarding it was sincere and fervent.

The greater part of the paper was devoted to a discussion of the methods of training those who are in a position to devote not less than four years to a course designed to fit them at the end to begin practice as junior or senior technical assistants with every prospect of rising rapidly to higher responsible positions. At the same time, the needs of other classes less favourably placed, and of those who are to fill the lower positions, were not lost sight of, and especially of that class of men already in the industry who *must* be given opportunities for keeping abreast of aeronautical developments as they proceed, and of making up from time to time the ground which the strenuous nature and preoccupation of their daily work must cause them to lose. The main subject of the paper, however, was the professional training of aeronautical engineers. The four years' course is divided up into two years' college training, not specially aeronautical, and two years specially aeronautical. The first year's work is devoted to a thorough grinding in mathematics, pure and applied, physics and chemistry, with the addition of engineering drawing and elementary engineering design, such as is required by all engineers, civil or mechanical. It is during this period that the ineligibles and slackers are weeded out. Indeed, instead of an entrance examination, determining whether a student shall take the whole course, the whole of the first year is treated as one long entrance examination, and if at the end of that period the student is obviously unfitted for an engineering career he is advised to seek another vocation. Special technological training begins with the second year, at the end of which works experience, lasting from Easter to October, is started. Distinct specialisation begins from the time the student goes to the works at Easter of this second session. Even during this first two years attention is given to the business or commercial side of engineering, although the precise application of commercial principles comes in the later stages.

The college training, specially aeronautical, begins in the third year. The theory of machines and of mechanism, to lead up to which a good knowledge of mechanics is provided in the first two years, form a special feature of the advanced work in direct relation to many practical problems, such, for example, as the inertia effects of moving masses, whether free or constrained, as in the primary and secondary balancing of engine parts. The advanced design work for aircraft prime movers necessarily involves the advanced theory of heat engines. More advanced work than can well be included in the preliminary courses is given on the strength, elasticity and fatigue of materials, and proceeds concurrently with specialised instruction in other subjects of aeronautical engineering. The effects of fatigue on the various parts of an aeroplane structure, due to repetitions and variations of stresses, does not yet appear to have attracted serious attention in aeroplane work, and the authors are of opinion that some disastrous failures of machines are due to such effects.

Stress is laid on the fact that too much must not be expected from the trained product of a technical college in the matter of design and testing. The profession of aeronautics is a new one, and at present subject to ever varying change. A vast amount of experimental work has yet to be done, new ideas which are at present only emerging have yet to be tried, and new materials and combinations of materials have yet to be put to the test of actual utilisation. The manufacturer must be satisfied if the technical college gives him a trained intelligence under the guidance of a sound common sense; in short, a man who is well versed in the fundamental principles of aeronautics, and who can apply his knowledge to a reasonable extent in both experiment and design.

No synopsis of laboratory work finds a place in the syllabus for the reason that it is felt much of the laboratory instruction will necessarily be of the nature of research. A very prominent part of the laboratory equipment must consist of a wind tunnel, with its motor-driven propeller, and provided with indicating and recording instruments for experiments and research on models of planes and wing surfaces or structures, on models or parts of aeroplane structures, &c.

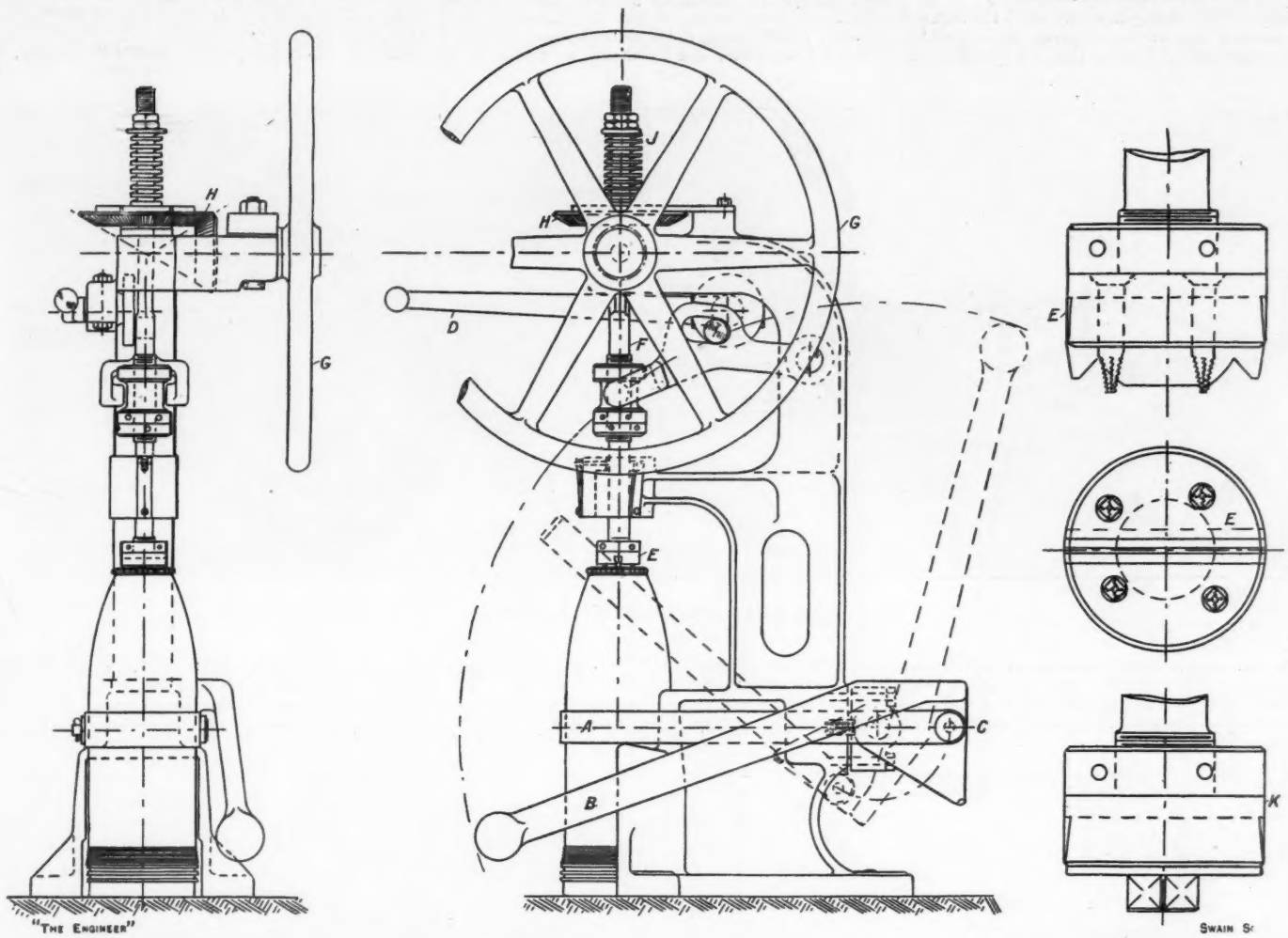
In the general scheme, the bulk of the workshop and practical work is to be taken in actual and not the college workshops during the last two summer periods, and, if in particular cases, additional work of this kind is deemed necessary to be undertaken, it would naturally fall to be taken at the end of the fourth year. In this connection it is suggested that visits should be paid to flying grounds during the last two years, and possibly flights might be undertaken, as passengers, in order still further to familiarise the students with the behaviour of the machines upon the theory and design of which they have been concerned. The day is even looked to when the requirements of education and research will justify an experimental aerodrome, laboratory and flying ground; the chief obstacle at the present time is the necessarily heavy expenditure.

The position as regards the better technical training of those workmen already engaged in the industry is gone into in the paper, and reliance is placed on lectures, such as those the Aeronautical Society has conducted at Hendon during the past six months, and which were repeated at Cardiff. Similar lectures, but more advanced, coupled with a design and drawing-office class, are recommended for higher ranks. Finally, the necessity for provision for research and scholarships is touched upon, and in order that the laboratory work, which as already stated, must necessarily be of the nature of research work, and that it may be efficiently carried out, it is regarded as essential that the ordinary teaching staffs should be strengthened by the appointment of (*a*) research assistants, (*b*) the establishment of senior scholarships and research studentships, and (*c*) the establishment of junior scholarships, on the lines set forth in the report issued last year by the Department of Scientific and Industrial Research.

There was no adverse criticism of Dr. Walmsley's scheme in the discussion; indeed, it is not a little curious that a precisely similar curriculum has been arranged at East London College without knowledge on either side of what the other was doing. In the absence of Sir E. H. Busk, who is so closely associated with technical education, and who was prevented at the last minute from presiding, the chair was taken by Mr. A. E. Berriman, chief engineer to the Daimler Motor Car Company.

A MEDAL, known as the Harriman medal, and struck in memory of Mr. E. H. Harriman, is awarded each year by the American Museum of Safety to the railroad or line of industry that has the best record in the prevention of accidents. For 1916 it has been awarded to the Illinois Central Railway Company. The award is due largely to the fact that the Illinois Central carried 50,000 suburban passengers a day during the year without a fatality, and that in the sixty-five years of its existence there has not been a single passenger fatality in suburban service due to the fault of the railroad. Safety of employees figured, however, equally with safety of passengers in the award. On its entire system the company handled 42,000,000 passengers last year without a fatality.

GLOVER AND CO.'S PLUG EXTRACTOR FOR SHELLS



OBITUARY.

GENERAL HOLLAND.

WE regret to announce the death on the 26th ult., at the age of 57, of Brigadier-General Gerald Edward Holland, C.B., C.M.G., C.I.E., L.S.C., R.E., Director of Inland Water Transport in France, and well known as the Marine Superintendent of the London and North-Western Railway. General Holland was born in Dublin, and joined the Royal Indian Marine in 1880, being promoted to lieutenant two years later. He served with the Burma Expeditionary Force in 1885-89, and with the Chin Lushai Expedition in 1889-90, when he was mentioned in dispatches, and received the D.S.O. In 1893 he was made commander, and was in charge of the Royal Indian Marine troopship Warren Hastings when that vessel was lost on Réunion Island in 1897. For this he was formally reprimanded, but, simultaneously, received a commendatory order of warm praise from the Viceroy in Council. During the South African War he served on the Naval Transport Staff as Divisional Officer, being three times mentioned in dispatches, and created C.I.E. Subsequently he was for three years principal port officer at Rangoon, and, retiring from the Indian Marine twelve years ago, he was appointed Marine Superintendent to the London and North-Western Railway Company. Whilst at Holyhead he designed the Rathmore in 1908, and the Greenore in 1912, also a coal loading barge, which avoided the manual coaling of ships. A third vessel, the Curraghmore, for the Greenore service, has not yet been delivered. On the outbreak of war he founded the Anglesey Royal Engineers—now commanded by his only son—and he went subsequently to France to take charge of the Inland Water Transport, being made a Colonel, R.E. At the beginning of 1916 he was created C.M.G., and, subsequently, C.B. He also had orders conferred upon him by the Kings of Belgium and Italy, being made Officer of the Order of Leopold by the former, and Officer of the Order of St. Maurice and St. Lazarus by the latter, and has been twice mentioned in dispatches. General Holland died at St. Leonards-on-Sea from sickness contracted whilst on active service, and was buried with naval and military honours at Holyhead on Friday last.

WILLIAM J. GRIGGS.

THE death is announced of Mr. William J. Griggs as having taken place at Halfway Tree, Jamaica, on the 20th May last.

Mr. Griggs, who was born on June 20th, 1876, at Romford, in Essex, was trained as an engineer at the Locomotive, Carriage and Wagon Works of the North London Railway, where he afterwards became draughtsman, and inspector and tester of materials. Subsequently he went to Africa as a district locomotive superintendent, and from thence to Cuba as a chief locomotive, carriage and wagon superintendent. On returning to this country he was for a short time an inspector for the Crown Agents for the Colonies, and finally went to Jamaica as chief locomotive, carriage and wagon superintendent of the Jamaica Government Railway. At the time of his death he had completed his three years' agreement in this position, and held a post on the Civil Establishment of the Colony.

PLUG EXTRACTOR FOR SHELLS.

AT a certain stage in the manufacture of shell it is necessary to screw into the nose a temporary wooden plug, which is frequently difficult to remove by ordinary means, especially if the plug has become swollen by damp. Sometimes when the use of levers has failed to effect the removal, a mallet and chisel are used to smash the rims of the plugs, which are then frequently broken into the shell. In order to obviate these troubles, the firm of M. Glover and Co., Holbeck-lane, Leeds, has designed and introduced a machine for the effective removal of the plugs with the minimum of exertion. The construction and operation of the machine are shown in the accompanying drawings, from which it will be seen that the shell is first securely gripped. Then, by means of a few turns of a hand wheel, the plug is removed.

The machine can be fixed on a bench or table. The shell is placed in a recess in a vice, in which it is firmly held by means of the hand A, which is brought down and tightened by means of the handle B pivoted at C. After this has been accomplished, the depression of the hand lever D against the action of the spring J causes the tongued and spiked clutch E on the end of the spindle F to engage the plug. Then, by turning the hand wheel G, which is geared to the spindle by the bevel wheels H, the plug is unscrewed. On the end of the handle or lever B is a projection or lug, by means of which the gripping hand is released after the plug has been withdrawn. The machine can also be adapted for the removal of metal plugs by replacing the tongued and spiked clutch E by an attachment K having a square projection on the bottom for fitting into a corresponding recess in the plug.

We understand that these machines are in use in several shell factories and are giving satisfaction.

ECONOMY IN COAL CONSUMPTION.

THE Controller of Coal Mines has been advised that an economy in the use of coal can be effected, and much inconvenience avoided during the next and succeeding winter, by the giving effect, as far as possible, to the following suggestions:—

(1) *Power Uses.*—That the various factory owners throughout the country, who at present generate their own power by means of coal, should make arrangements for taking their power requirements from an outside source, in districts where the power supplies have a margin available, and thereby reduce the total amount of coal used. The Coal Controller will assist, as far as possible, in obtaining priority for plant, machinery, and motors required, provided a substantial coal saving can be demonstrated.

(2) *Use of Coke.*—The use of locally produced coke breeze in place of coal as much as possible in domestic grates, factory furnaces—where such cannot take an outside supply—public utility plants at light loads, also in baths and wash-houses, provided coke is available in sufficient quantities.

(3) *Public Services.*—The curtailment of those public services which entail coal consumption, such as early and late tramway running—after consultation with the Ministry of Munitions, where munition workers are likely to be affected—and the prevention of unneccessary use of water.

(4) *Stocks.*—The accumulation of stocks in the summer months, as far as deliveries will permit, of the coal required during the winter months, the cost of such storage being considered as a form of insurance against the probable coal shortage.

(5) *Cooking and Heating.*—The installation of gas or electric cooking and heating appliances in public and private buildings, with a view of saving coal generally, and lessening the serious inconvenience to the public next winter, should the local distribution of coal become irregular or insufficient.

(6) *Emergency Disconnection.*—The application to the Board of Trade by the electric supply authority for sanction under Regulation B.1, to disconnect classes of non-essential consumers in cases of urgent necessity, in order to enable the supply to be continued to munition and other essential users. This power should be obtained, although it need not be put into execution until the necessity arises.

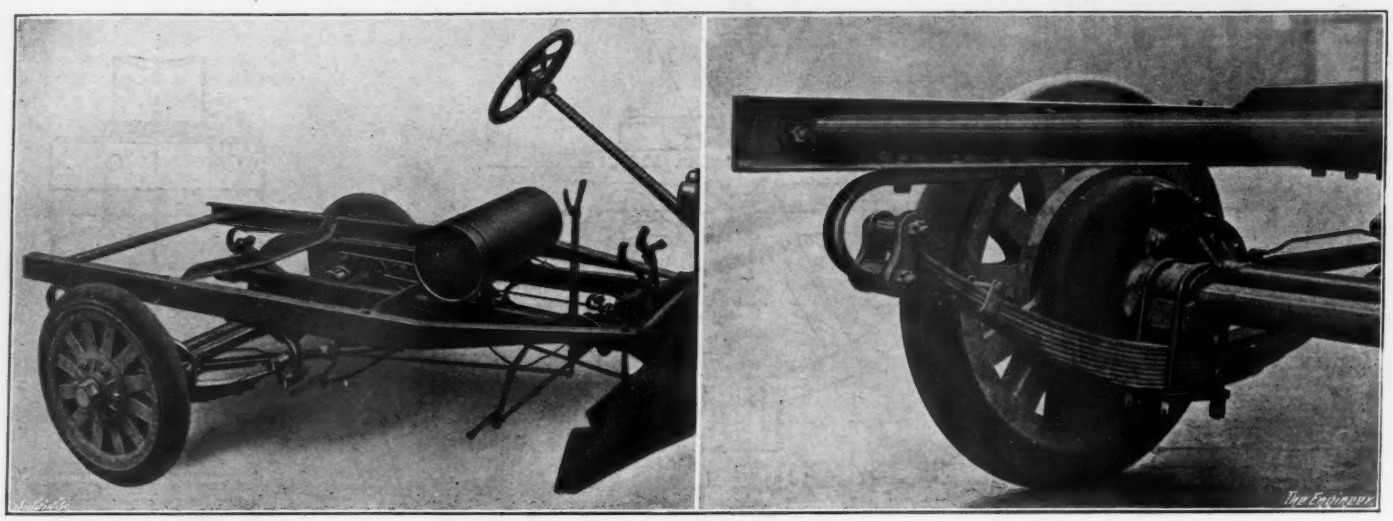
(7) *Interconnection.*—Making arrangements as suggested in the letter of the Board of Trade, dated May 25th, 1916, with the neighbouring towns to interconnect electric distribution systems or generating plants by means of underground cables, or in suitable cases, of temporary overhead wires over the intervening country, so as to enable one or two of the most economical power stations in each district to supply several towns at light loads, instead of each town having to run its own power station uneconomically at such times. This would also enable the various power plants to shut down in turn during week-ends and holidays, to effect plant repairs, and would provide some amount of power at call as a stand-by in case of coal supplies giving out locally.

In order to carry out the last suggestion, the Controller is advised that additional powers will have, in some cases, to be obtained both as regards passing over private property, trading between public utility companies and local authorities and possibly relief from some of the existing Power Supply Regulations; and if cases are brought to his notice, they will receive his assistance where the saving in coal would warrant the provision of the necessary plant, mains, &c.

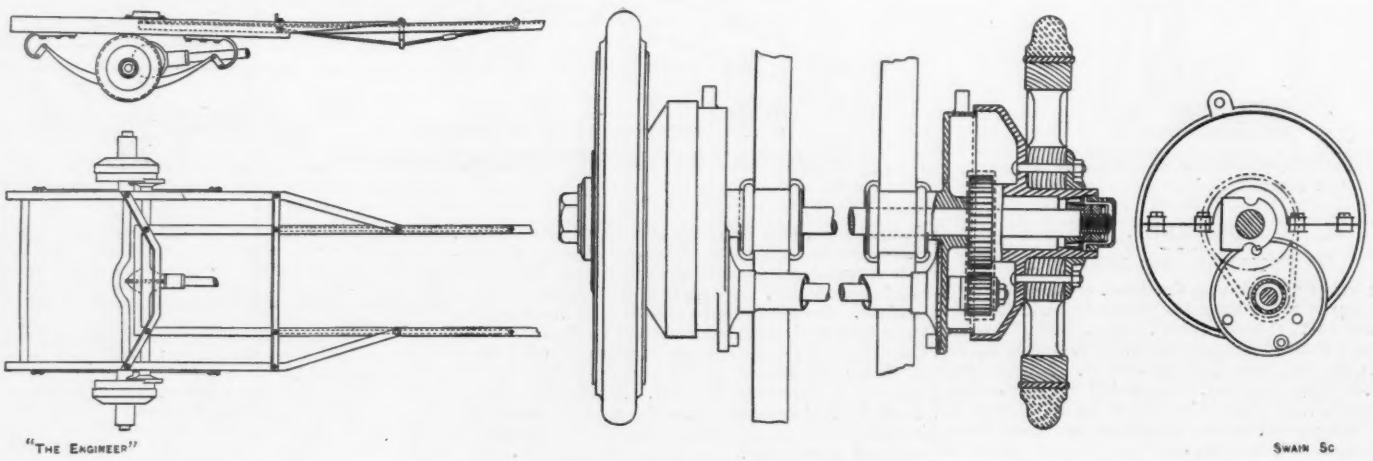
THE CONVERSION OF FORD CARS INTO COMMERCIAL VEHICLES.

THERE probably never was a time when the demand for commercial vehicles was so great as the present, and it is somewhat unfortunate that this period should coincide with one in which the maximum difficulties in obtaining supplies are encountered. In the first place many makers of commercial vehicles have switched over bodily to the manufacture of munitions of one sort or another; next, the importation of lorries is almost entirely prohibited to-day, and lastly, the permission of a Government Department has to be obtained before a new vehicle can be purchased at all, so that the proposition has to surmount. It may, however, be overcome by those who only require to carry light loads not exceeding, say, one ton, by buying up a second-hand Ford car which may have been put out of commission as a pleasure vehicle owing to the restrictions of the Petrol Control Committee, and by fitting to it one of the many different devices now on the market for making that vehicle suitable for carrying such loads.

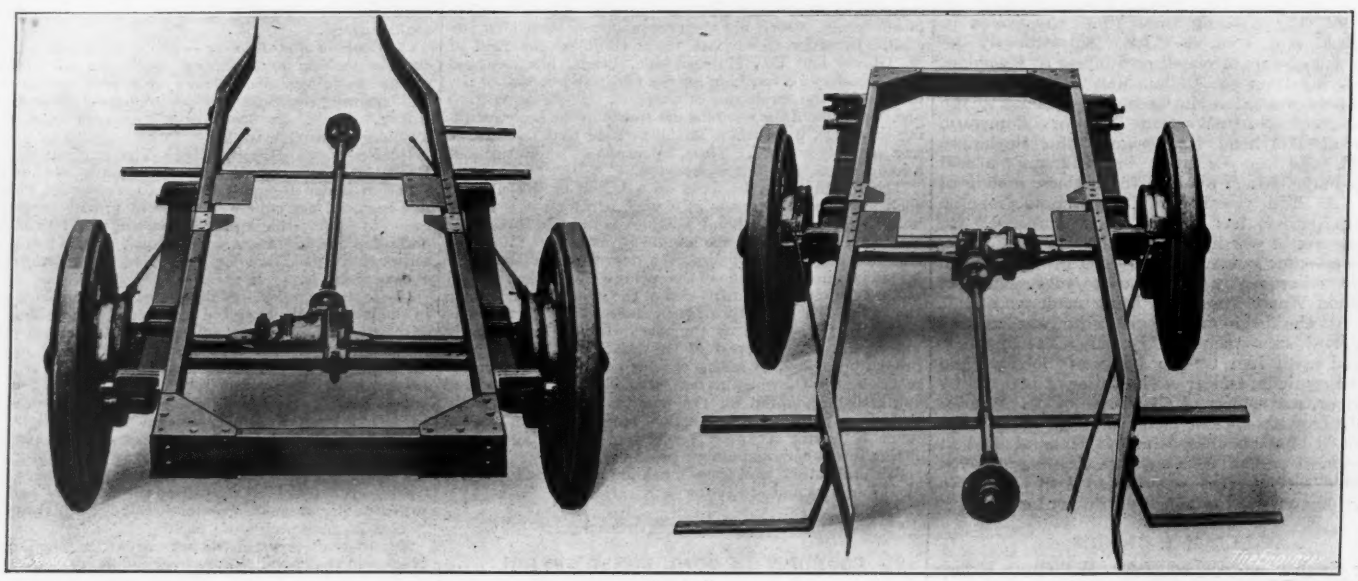
It is very interesting to study the different ways in which the problem has been tackled by the various firms who have approached it, and we propose to describe and comment on some of the makes, though we are not prepared to say that we have covered the whole ground.



Figs. 1 and 2—THE "KARYTON" ADAPTOR



Figs. 3 and 4—DETAILS OF THE "KARYTON" ADAPTOR



Figs. 5 and 6—THE "HUDFORD UNIT"

We will first take the "Tonlode," as being a British invention, which is handled by Messrs. Morris, Russell and Co., of 75, Curtain-road, E.C. This arrangement consists of a comparatively short length of channel frame, with the necessary cross members, which bolts on to the Ford chassis, and carries underslung springs with wheels and a weight-carrying axle, the wheels and transverse spring of the Ford car being removed. The original Ford back axle remains, but it is used purely as a driving axle by means of pinions fitted on the ends in place of the driving wheels, and these pinions mesh with gear wheels on the weight-carrying axle; these gears being enclosed in a gear case carried on the wheels. The two shafts are kept to their proper spacing and alignment by means of steel discs which form the cover of the gear case. This design has the effect of increasing the track to 6ft., and it also leads to a rather considerable amount of unsprung weight. The frame is supplied ready drilled to fit the existing holes in the

chassis, so that it is only an assembling job to fit up, and the cost of so doing should not be great. The price of this adaptor is £80, and it certainly appears to be a good, sound job. Another pattern, the "Karyton"—Figs. 1 to 4—is supplied by the same makers. In it the drive is carried from the Ford shaft without any trouble. The device may be more expensive to buy, but it is as simple as any to fit up. One nice feature is that it embodies an internal rack and pinion drive, which finds great favour among commercial vehicle users. We think the designer is wise in supplying this as a complete unit in view

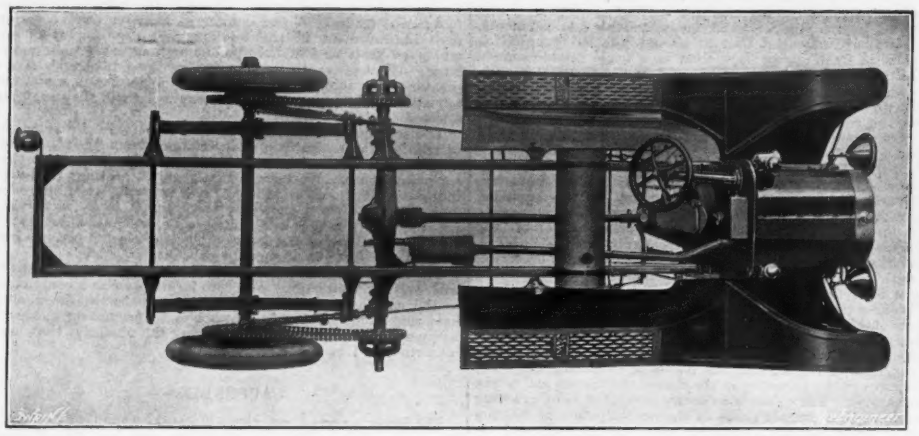


FIG. 7—THE "MAKE-A-TRUCK" ADAPTOR IN POSITION

axle to the weight-carrying axle by means of short chains, which, we are inclined to think, would give better results. The platform thus furnished is 6ft. wide by 6ft. 6in. long.

The "Hudford Unit"—Figs. 5 and 6—handled by Messrs. Markt and Co., of 100, Clerkenwell-road, is on

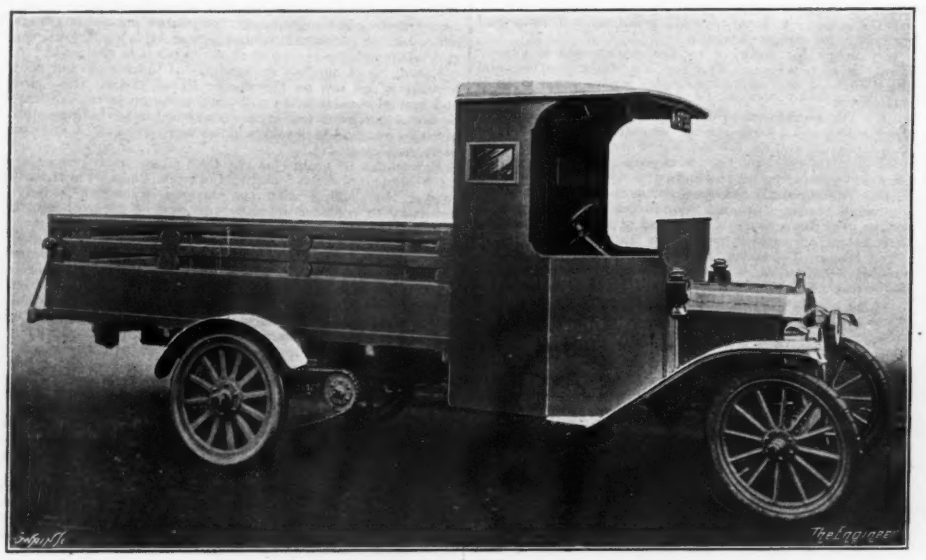
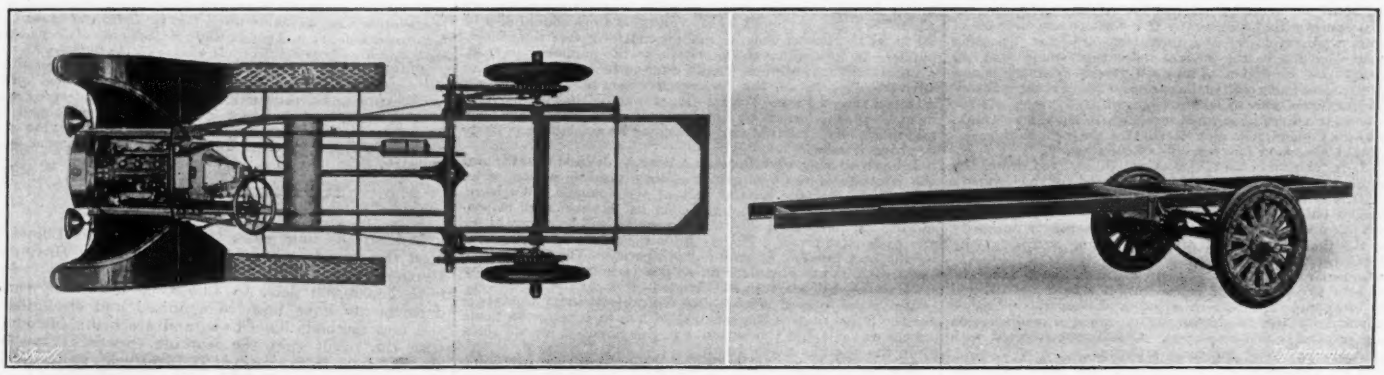


FIG. 8—FORD CAR WITH "MAKE-A-TRUCK" CONVERSION

much the same lines, but is more expensive, costing £110, and it retains the fewest of the original Ford parts of any, but this, in view of the arrangement adopted in this particular instance, is probably the best thing to do. The parts supplied consist of the frame, the back axle, springs, differential casing and

of the unskilled labour now only available for fitting up such a job.

Then come two devices which are very similar in design, though strangely dissimilar in what we should have thought an important feature, namely, that the original Ford chassis should be disturbed as little as possible. The "Make-a-Truck"—Figs. 7 and 8—handled by the British American Import Company, of 11, Haymarket, and the Smith "Form-a-Truck"—Figs. 9 and 10—handled by Mr. C. P. Elliot, 8, Bramber-road, Fulham, both consist of what is really a weight-carrying trailer with a Ford chassis as tractor.



FIGS. 9 and 10—THE "FORM-A-TRUCK" ADAPTOR

gear, propeller and driving shafts, brake drum, torque rods and wheels, the corresponding Ford parts, except, of course, the frame, being eliminated. The new parts are fitted up on the new frame, which bolts on to the Ford frame as in the other designs, and the new propeller shaft bolts direct on to the gear-box

In the case of the "Make-a-Truck" the frame of the trailer is fitted to the chassis, which has to be drilled for the connecting bolts; the Ford rear wheels and transverse spring are removed, and the place of the wheels is taken by a pair of chain sprockets, held in place by the hub caps, and connected by chains to chain wheels on the weight-carrying axles. It is to be noted that the track of the rear wheels is thereby increased beyond that of the front wheels. The car shown in Fig. 8 was made for the Elder-Dempster Company. In the "Form-a-Truck" the Ford axle and casing are replaced by shorter ones, keeping the track of the back wheels the same as that of the front wheels, while the holes in the new frame are drilled to template to coincide with existing holes in the Ford chassis. The cross spring is also retained, but only comes into action when the load is on. The work involved in the conversion is thus somewhat heavier, and a more costly vehicle results, but this is to some extent compensated for by the equal tracks, the easy springing at light loads, and the shorter overhang on the spring hangers.

The last of the class with which we shall deal, the "Olsen Unit"—Figs. 11 and 12—handled by Messrs. Bramco, of Coventry. It is chiefly noticeable on account of the fewness of parts, and the smallness of the altera-

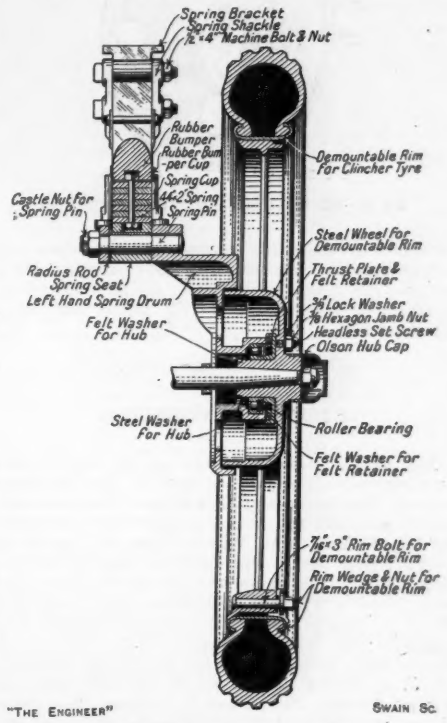


FIG. 11—PART OF "OLSEN UNIT"

tions necessitated, and the consequent low cost price namely, £42. In this case the designer has taken what we consider to be the rather bold step of retaining the whole of the original Ford chassis, with the exception of the back wheels, and fitting new hubs, running on roller bearings, carrying steel wheels, to which the whole of the load is conveyed through a special housing from a new and stiff pair of springs from the chassis. The design appeals to us for its great simplicity, and the fact that it is amply strong for the work it has to do seems to be borne out by the statement of the makers that it has been tested to a load capacity of 5 tons. It should be observed that there is only a 25 per cent. gear reduction below the original Ford road wheel speeds, which is obtained by the expedient of fitting smaller diameter wheels, while in the case of all the others the speed is geared down about 50 per cent. on the chain or gear wheels, and wheels of the original size are used, so that road damage is minimised. Thus, with the Olsen unit, either the engine has to be run below its normal speed and power, or the vehicle may have to run much too fast, and will lose some of its hill-climbing capacity. For town and light delivery work, however, these objections do not so much apply, and the attach-

ments should appeal to those who have such work to do.

From this brief review it will be seen that of the six types dealt with, one uses the internal gear drive, one the spur and pinion drive, three use the chain drive, one on an increased track width, while the sixth uses the existing drive, and simply strengthens up the wheels, while ensuring that the weight shall fall direct upon the wheels. That these devices are in great request, and that they do fulfil a real want is evidenced by the quite considerable quantities that have already been imported into this country, and that manufacture is now being taken up here to as large an extent as is permitted by the labour and materials supplied.

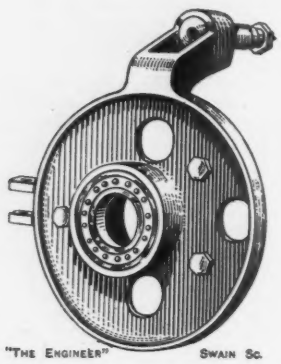


FIG. 12—SPRING DRUM OF "OLSEN UNIT"

INDUSTRIAL COUNCILS.

ONE of the sub-committees of the Government Reconstruction Committee handles the Relations between Employees and Employers. This Sub-committee, generally known by the name of its chairman, the Right Hon. J. H. Whitley, has just issued the interim report, which is printed in a slightly abridged form below. The members of the Sub-committee are :—The Right Hon. J. H. Whitley, M.P., chairman ; Mr. F. S. Button, Mr. G. J. Carter, Professor S. J. Chapman, Sir Gilbert Claughton, Bart., Mr. J. R. Clynes, M.P., Mr. J. A. Hobson, Miss Susan Lawrence, Mr. J. J. Mallon, Sir Thos. R. Ratcliffe-Ellis, Mr. Robert Smillie, Mr. Allan M. Smith, Miss Mona Wilson, with Mr. H. J. Wilson, Ministry of Labour, and Mr. Arthur Greenwood, as secretaries.

The terms of reference to the Sub-committee were :—

"(1) To make and consider suggestions for securing a permanent improvement in the relations between employers and workmen.

"(2) To recommend means for securing that industrial conditions affecting the relations between employers and workmen shall be systematically reviewed by those concerned, with a view to improving conditions in the future."

In the interests of the community it is vital that after the war the co-operation of all classes, established during the war, should continue, and more especially with regard to the relations between employers and employed. For securing improvement in the latter, it is essential that any proposals put forward should offer to workpeople the means of attaining improved conditions of employment and a higher standard of comfort generally, and involve the enlistment of their active and continuous co-operation in the promotion of industry. To this end, the establishment for each industry of an organisation, representative of employers and workpeople, to have as its object the regular consideration of matters affecting the progress and well-being of the trade from the point of view of all those engaged in it, so far as this is consistent with the general interest of the community, appears to us necessary.

With a view to providing means for carrying out the policy outlined above, we recommend that his Majesty's Government should propose without delay to the various associations of employers and employed the formation of Joint Standing Industrial Councils in the several industries, where they do not already exist, composed of representatives of employers and employed, regard being paid to the various sections of the industry and the various classes of labour engaged.

The appointment of a chairman or chairmen should, we think, be left to the Council, who may decide that these should be—

(1) A chairman for each side of the Council.

(2) A chairman and vice-chairman selected from the members of the Council (one from each side of the Council).

(3) A chairman chosen by the Council from independent persons outside the industry ; or

(4) A chairman nominated by such person or authority as the Council may determine or, failing agreement, by the Government.

The Councils should meet at regular and frequent intervals. The objects to which their consideration should be directed should be appropriate matters affecting the several industries and particularly the establishment of a closer co-operation between employers and employed. Questions connected with demobilisation will call for early attention.

One of the chief factors in the problem, as it at first presents itself, consists of the guarantees given by the Government, with Parliamentary sanction, and the various undertakings entered into by employers, to restore the trade union rules and customs suspended during the war. While this does not mean that all the lessons learnt during the war should be ignored, it does mean that the definite co-operation and acquiescence by both employers and employed must be a condition of any setting aside of these guarantees or undertakings, and that, if new arrangements are to be reached, in themselves more satisfactory to all parties but not in strict accordance with the guarantees, they must be the joint work of employers and employed.

The matters to be considered by the Councils must inevitably differ widely from industry to industry, as different circumstances and conditions call for different treatment, but we are of opinion that the suggestions set forth below ought to be taken into account, subject to such modification in each case as may serve to adapt them to the needs of the various industries. In the well-organised industries, one of the first questions to be considered should be the establishment of local and works organisations to supplement and make more effective the work of the central bodies. It is not enough to secure co-operation at the centre between the national organisations ; it is equally necessary to enlist the activity and support of employers and employed in the districts and in individual establishments. The National Industrial Council should not be regarded as complete in itself ; what is needed is a triple organisation—in the workshops, the districts, and nationally. Moreover, it is essential that the organisation at each of these three stages should proceed on a common principle, and that the greatest measure of common action between them should be secured.

With this end in view, we are of opinion that the following proposals should be laid before the National Industrial Councils :

(*a*) That District Councils, representative of the trade unions and of the employers' association in the industry, should be created, or developed out of the existing machinery for negotiation in the various trades.

(*b*) That Works Committees, representative of the management and of the workers employed, should be instituted in particular works to act in close co-operation with the district and national machinery.

As it is of the highest importance that the scheme making provision for these committees should be such as to secure the support of the trade unions and employers' associations concerned, its design should be a matter for agreement between these organisations. Just as regular meetings and continuity of co-operation are essential in the case of the National Industrial Councils, so they seem to be necessary in the case of the district and works organisations. The object is to secure co-operation by granting to workpeople a greater share in the consideration of matters affecting their industry, and this can only be achieved by keeping employers and workpeople in constant touch.

The respective functions of works committees, district councils, and national councils will no doubt require to be determined separately in accordance with the varying conditions of different industries. Care will need to be taken in each case to delimit accurately their respective functions, in order to avoid overlapping and resulting friction. For instance, where conditions of employment are determined by national agreements, the district councils or works committees should not be allowed to contract out of conditions so laid down nor, where conditions are determined by local agreements, should such power be allowed to works committees.

Among the questions with which it is suggested that the National Councils should deal or allocate to district councils or works committees the following may be selected for special mention :—

(i.) The better utilisation of the practical knowledge and experience of the workpeople.

(ii.) Means for securing to the workpeople a greater share in and responsibility for the determination and observance of the conditions under which their work is carried on.

(iii.) The settlement of the general principles governing the conditions of employment, including the methods of fixing, paying, and readjusting wages, having regard to the need for securing to the workpeople a share in the increased prosperity of the industry.

(iv.) The establishment of regular methods of negotiation for issues arising between employers and workpeople, with a view both to the prevention of differences, and to their better adjustment when they appear.

(v.) Means of ensuring to the workpeople the greatest possible security of earnings and employment, without undue restriction upon change of occupation or employer.

(vi.) Methods of fixing and adjusting earnings, piecework prices, &c., and of dealing with the many difficulties which arise with regard to the method and amount of payment apart from the fixing of general standard rates, which are already covered by paragraph (iii.).

(vii.) Technical education and training.

(viii.) Industrial research and the full utilisation of its results.

(ix.) The provision of facilities for the full consideration and utilisation of inventions and improvement designed by workpeople, and for the adequate safeguarding of the rights of the designers of such improvements.

(x.) Improvements of processes, machinery, and organisation and appropriate questions relating to management, and the examination of industrial experiments, with special reference to co-operation in carrying new ideas into effect, and full consideration of the workpeople's point of view in relation to them.

(xi.) Proposed legislation affecting the industry.

The methods by which the functions of the proposed councils should be correlated to those of joint bodies in the different districts, and in the various works within the districts, must necessarily vary according to the trade. It may, therefore, be the best policy to leave it to the trades themselves to formulate schemes suitable to their special circumstances, it being understood that it is essential to secure in each industry the fullest measure of co-operation between employers and employed, both generally, through the national councils, and specifically, through district committees and workshop committees.

It would seem advisable that the Government should put the proposals relating to National Industrial Councils before the employers' and workpeople's associations, and request them to adopt such measures as are needful for their establishment where they do not already exist. Suitable steps should also be taken, at the proper time, to put the matter before the general public. In forwarding the proposals to the parties concerned, we think the Government should offer to be represented in an advisory capacity at the preliminary meetings of a council, if the parties so desire. We are also of opinion that the Government should undertake to supply to the various councils such information on industrial subjects as may be available and likely to prove of value.

It has been suggested that means must be devised to safeguard the interests of the community against possible action of an anti-social character on the part of the councils. We have, however, here assumed that the councils, in their work of promoting the interests of their own industries, will have regard for the national interest. If they fulfil their functions they will be the best builders of national prosperity. The State never parts with its inherent over-riding power, but such power may be least needed when least obtruded.

It appears to us that it may be desirable at some later stage for the State to give the sanction of law to agreements made by the councils, but the initiative in this direction should come from the councils themselves.

The plans sketched in the foregoing paragraphs are applicable in the form in which they are given only to industries in which there are responsible associations of employers and workpeople which can claim to be fairly representative. The case of the less well-organised trades or sections of a trade necessarily needs further consideration. We hope to be in a position shortly to put forward recommendations that will prepare the way for the active utilisation in these trades of the same practical co-operation as is foreshadowed in the proposals made above for the more highly organised trades.

It may be desirable to state here our considered opinion that an essential condition of securing a permanent improvement in the relations between employers and employed is that there should be adequate organisation on the part of both employers and workpeople. The proposals outlined for joint co-operation throughout the several industries depend for their ultimate success upon there being such organisation on both sides ; and such organisation is necessary also to provide means whereby the arrangements and agreements made for the industry may be effectively carried out.

We have thought it well to refrain from making suggestions or offering opinions with regard to such matters as profit-sharing, co-partnership, or particular systems of wages, &c. It would be impracticable for us to make any useful general recommendations on such matters, having regard to the varying conditions in different trades. We are convinced, moreover, that a permanent improvement in the relations between employers and employed must be founded upon something other than a cash basis. What is wanted is that the workpeople should have a greater opportunity of participating in the discussion about, and adjustment of, those parts of industry by which they are most affected.

The schemes recommended in this Report are intended not merely for the treatment of industrial problems when they have become acute, but also, and more especially, to prevent their becoming acute. We believe that regular meetings to discuss industrial questions, apart from, and prior to, any differences with regard to them that may have begun to cause friction, will materially reduce the number of occasions on which, in the view of either employers or employed, it is necessary to contemplate recourse to a stoppage of work.

We venture to hope that representative men in each industry, with pride in their calling, and care for its place as a contributor to the national well-being, will come together in the manner here suggested, and apply themselves to promoting industrial harmony and efficiency, and removing the obstacles that have hitherto stood in the way.

APPENDIX.

The following questions were addressed by the Reconstruction Committee to the Sub-Committee on the Relations between Employers and Employed in order to make clear certain points which appeared to call for further elucidation. The answers given are subjoined.

Q.—(1) *In what classes of industries does the Interim Report propose that industrial councils shall be established ? What basis of classification has the Sub-committee in view ?*

A.—(1) It has been suggested that for the purpose of considering the establishment of industrial councils, or other bodies designed to assist in the improvement of relations between employers and employed, the various industries should be grouped into three classes—(*a*) industries in which organisation on the part of employers and employed is sufficiently developed to render the councils representative ; (*b*) industries in which either as regards employers and employed, or both, the degree of organisation, though considerable, is less marked than in (*a*) and is insufficient to be regarded as representative ; and (*c*) industries in which organisation is so imperfect, either as regards employers or employed, or both, that no associations can be said adequately to represent those engaged in the trade.

It will be clear that an analysis of industries will show a number which are on the border lines between these groups, and special consideration will have to be given to such trades. So far as groups (*a*) and (*c*) are concerned, a fairly large number of trades can readily be assigned to them ; group (*b*) is necessarily more indeterminate.

For trades in group (*a*) the Committee have proposed the establishment of Joint Standing Industrial Councils in the several trades. In dealing with the various industries it may be necessary to consider specially the case of parts of industries in group (*a*) where organisation is not fully developed.

Q.—(2) *Is the machinery proposed intended to be in addition to, or in substitution for, existing machinery ? Is it proposed that existing machinery should be superseded ? By "existing machinery" is meant conciliation boards and all other organisations for joint conference and discussion between employers and employed.*

A.—(2) In most organised trades there already exist joint bodies for particular purposes. It is not proposed that the industrial councils should necessarily disturb these existing bodies. A council would be free, if it chose, and if the bodies concerned approved, to merge existing committees, &c., in the Council, or to link them with the Council as sub-committees.

Q.—(3) *Is it understood that membership of the councils is to be confined to representatives elected by employers' associations and trade unions ? What is the view of the Sub-Committee regarding the entry of new organisations established after the councils have been set up ?*

A.—(3) It is intended that the councils should be composed only of representatives of trade unions and employers' associations, and that new organisations should be admitted only with the approval of the particular side of the council of which the organisation would form a part.

Q.—(4) (*a*) *Is it intended that decisions reached by the councils shall be binding upon the bodies comprising them ? If so, is such binding effect to be conditional upon the consent of each employers' association or trade union affected ?*

A.—(4) (*a*) It is contemplated that agreements reached by industrial councils should (whilst not, of course, possessing the binding force of law), carry with them the same obligation of observance as exists in the case of other agreements between employers' associations and trade unions. A council, being on its workmen's side, based on the trade unions concerned in the industry, its powers or authority could only be such as the constituent trade unions freely agreed to.

Q.—(4) (*b*) *In particular, is it intended that all pledges given either by the Government or employers for the restoration of trade union rules and practices after the war shall be redeemed without qualification unless the particular trade union concerned agrees to alteration : or, on the contrary, that the industrial council shall have power to decide such question by a majority vote of the workmen's representatives from all the trade unions in the industry ?*

A.—(4) (*b*) It is clearly intended that all pledges relating to the restoration of trade union rules shall be redeemed without qualification unless the particular trade union concerned agrees to alteration ; and it is not intended that the Council shall have power to decide such questions by a majority vote of the workmen's representatives from all the trade unions in the industry.

DURING the four years that Mr. Howard Elliott has been the president of the New York, New Haven and Hartford Railway, the floating debt has been reduced from 56,000,000 dols. to 43,000,000 dols., the various departments have been re-organised and strengthened, and new methods have been, and are being, introduced, with the result that the working expenses have been brought down from a ratio of 71.78 per cent. to the receipts to 66.92 per cent. Public opinion has, further, become more favourable to the company, and the relations with the State and Federal authorities have been harmonious and co-operative. Mr. Elliott, having brought the company into this more favourable condition, feels that he may retire, and he has been succeeded by Mr. E. J. Pearson, who is spoken of as one of the hardest workers of the many hard-working railroad men in the United States. Like many other presidents, general managers, and administrators in the United States, Mr. Pearson is an engineer by profession.

RAILWAY MATTERS.

THE Southern Railway Company is aiding in discouraging the emigration of negroes from the southern states.

THE Minister of Transportation in the new Italian Cabinet is Senator Riccardo Bianchi, who, as Commendatore Bianchi, was the successful Director-General of the Italian State Railways.

THE Board of the Northern Railway of France has agreed to grant the request of M. Sartiaux, the company's Ingénieur en chef de l'Exploitation, to retire. He has been appointed Ingénieur en chef honoraire de l'Exploitation.

THE amount of coal brought to London during the first five months of 1914 were: rail-borne, 3,369,518 tons; and sea-borne, 3,657,090 tons. During the corresponding period for 1917 it was 4,571,306 tons rail-borne, and 2,560,082 tons sea-borne.

PRESIDING at the annual meeting of the Railway Benevolent Instituton, Lord George Hamilton said that the income for last year showed an increase of £8338 over that for the preceding year; of the increase £7092 came from donations and £279 from the New Year's Day collection.

DURING the year ended June 30th, 1916, there was a falling off of 83,000 tons of freight on the railways of Western Australia, owing to one million bags of wheat having had to remain stacked in the country districts instead of being transported to the seaboard, owing to the scarcity of shipping.

OVER the gateway leading to the shops of the Nashville Chattanooga and St. Louis Railway there is printed a notice to men seeking employment, which says "Unless you are willing to be careful to avoid injury to yourself and fellow workmen, do not ask for employment. We do not want careless men in our employ."

THE Great Northern (U.S.A.) Company has issued a note to its servants stating that all its men enlisting in the Army or Navy will have their positions restored to them upon returning from such service, and also that all seniority and pension rights will be retained. The Northern Pacific has issued similar circulars.

A CHANGE in the attitude of juries in America towards railway companies was revealed in a case in Illinois recently. The motor car in which a farmer was riding was struck by a train and the farmer killed. His widow sued the company, but the jury rejected her claim on the ground that the man was killed through his own negligence.

HAVING regard to the apparently indifferent way in which the tie-plates are attached to the sleepers in the United States, it is of interest to read in the recent annual report of the Pittsburg and Lake Erie Railway Company, that a tie-plating plant for screwing tie-plates under pressure to adzed and bored sleepers has been installed during the year.

THE Select Committee of the House of Lords, which, under the presidency of Lord Kintore, has been for some time considering the Bill of the South-Eastern and Chatham Railways for the strengthening of Charing Cross Bridge, passed the Bill on Wednesday, the 4th inst., after the inclusion in it of certain clauses, amongst which is included one prohibiting the widening of the bridge.

PRIOR to about a year ago the Broxburn Oil Company, Limited, had special rates granted in order to encourage domestic production of oil, but as they were preferential the North British Railway Company, in 1916, obtained powers to make a cash payment and cancel the agreement. This was done, and the rates were subsequently raised, but to this the oil company and others took exception in the Railway and Canal Commissions' Court. Judgment there was against the oil companies, and on June 13th their appeal in the Court of Session was dismissed.

ANSWERING a question as to the inter-availability of season tickets between London and Nottingham, the Parliamentary Secretary to the Board of Trade said that such inter-availability only came into operation where the train service had been so reduced as to be inconvenient. The Great Central Company maintained that this condition did not apply; but as he understood that inconvenience was being caused by the Great Central not acknowledging other companies' season tickets, he would communicate with the Railway Executive Committee on the matter.

ACCORDING to the export tables issued by the Board of Trade, the amount of railway material exported from the United Kingdom during the first five months of the present year was as follows, the figures in brackets being those for the corresponding period of 1916:—Locomotives, £633,543 (£527,389); steel rails, £273,751 (£238,532); carriages, £95,296 (£198,937); wagons, £205,767 (£248,800); wheels and axles, £70,957 (£138,006); tires and axles, £248,100 (£213,789); chairs and metal sleepers, £40,834 (£52,403); miscellaneous permanent way material, £201,114 (£192,368). The total permanent way exported was of a value of £518,021 (£519,604). The tonnage of rails was 17,207 (25,035), and of chairs and sleepers, 2895 (4965). The countries to which the exports are sent are no longer given in the Board of Trade returns.

SPEAKING in the House on the 28th ult. as to the work done during the year by the Ministry of Munitions, Dr. Addison said: "The other day Sir Douglas Haig paid a high tribute to the work of military transportation. It has been the duty of the Ministry (of Munitions) to supply the goods, except that the transfer to France of a certain amount of existing railway stock was undertaken by the Railway Executive Committee. The quantity of locomotives, trucks, and track required was so great that to manufacture all in time—even if there had been the raw material to spare, which there was not—would have been an impossibility. To meet the programme track was pulled up at home. India, Australia, and Canada sent their contributions. The Government of Canada held a meeting, and within forty-eight hours had arranged, if we wanted it, to pull up 800 miles of track and ship it. More than 2000 miles of track have already been supplied in a complete condition, and nearly 1000 locomotives of various kinds, apart from hundreds supplied by the Railway Executive Committee."

NOTES AND MEMORANDA.

THE inspection of gauges for the Ministry of Munitions by the National Physical Laboratory has assumed large dimensions; the number of gauges tested weekly averages 10,000.

THE increased area of land under plough in England and Wales this year, compared with 1916, is 300,000 acres, according to the official figures recently given in the House of Commons.

IT is reported from France that the Société des Mines de la Loire has recently started its first of two electric furnaces for the production of iron, utilising current from its own generating station.

THE American production of steel ingots and castings in 1916, as officially reported, was 42,773,680 gross tons, or 33 per cent. more than the output in 1915, which exceeded by a small percentage the output in 1912 and 1913.

BY using coal gas instead of petrol for the omnibuses owned by the Great Grimsby Street Tramways Company, the fuel cost per mile run has been reduced from 4.30d. to 1.66d.—with petrol at 2s. 2d. per gallon and coal gas at 2s. 6d. per 1000 cubic feet.

ACCORDING to the report of last year's working of the Manchester Corporation Tramways, the motor omnibuses, owned by the Corporation, ran 180,956 miles, and carried 1,416,760 passengers; the cost per mile run, including depreciation, was 9¼d., and the earnings nearly 9¾d.

OF the approximate 2,000,000 tons capacity of steel castings in the United States to-day about 52 per cent. are of basic and 48 per cent. acid steel. Almost 90 per cent. is produced in open-hearth furnaces, 8 per cent. in the converter, and the balance in crucible and electric furnaces.

ACCORDING to such a high authority as Professor Thomas H. Norton, nitric acid by the Birkeland and Eyde process of fixation of atmospheric nitrogen was but little more than half the cost of the acid from Chile saltpetre at 1914 prices, and by the Ostwald process, from ammonia obtained from cyanamide in the first place, even less than half.

THE power transmission lines of the Nevada-California Power Company's system form the longest chain yet projected, being about 666 miles from north to south. The current is generated by water power, an interesting feature of the plant being the utilisation of two high heads differing by 530ft. in the same power house and on the same 8000 horse-power impulse wheel.

THE world's platinum output is 1916 is reported in the United States Geological Survey as only 83,670 oz. troy, against 143,145 oz. in 1915 and 313,529 oz. in 1912, the largest output in the last eight years. Russia has hitherto furnished about 95 per cent. of the total, and Colombia has stood second. Of the 1916 output, Russia is credited with 57,860 oz., and Colombia with 25,000 oz. The United States produced only 750 oz. last year, which, however, is its largest output in eight years.

ACCORDING to a professional paper issued by the United States Geological Survey, there are many seams in the great coalfields in the Western States which at one time or another have become ignited, and have burned along their outcrops, baking the overlying strata into terra-cotta, and in places fusing and re-crystallising the shale and sandstone cover into a kind of natural slag. The burning, which in some cases may have been produced by lightning, in others by prairie or camp fires, has been so common as to affect most of the coal seams in an area of more than 200,000 square miles.

EARLY in 1910 seven electric furnaces were at work in Great Britain. Eighteen months later the number had increased to 16, which figure remained stationary for another year and a-half. At the beginning of 1916, 46 furnaces were in operation, and during the year an additional 42 furnaces were set to work, making a grand total of 88 in operation or under construction at the beginning of 1917. This amounts to about 19 per cent. of the world's total. The corresponding figures for the United States are:—At the beginning of 1910, 10; in July, 1913, 19; in January, 1915, 41; January, 1916, 73; and at the beginning of 1917, 136. During the last three years Germany has increased her furnaces from 34 to 52, and Austria from 10 to 18. According to a booklet issued by the Society for Electrical Development, of the furnaces installed, the Héroult type leads, the number installed being 181 out of a total of 471. The Rennerfelt comes next, with a total of 70. The induction type takes the third place with 50, and the fourth place is taken by the Grönwall-Dixon (Electro-Metals) type, with 29. Amongst the remainder, there are 24 Stassano, 23 Girod, and 20 Greaves-Etchells furnaces.

A PAPER which is to be presented by Mr. Floyd A. Nathan to the American Society of Civil Engineers next September dealing with the obstruction of bridge piers to the flow of water gives the results of a number of experiments on different models. Some of the conclusions arrived at are as follows:—(1) The best practical form of nose is either the half-round or the elliptical; the best form of tail is the double curve like a fish tail. The back-water is materially decreased by the adoption of such a tail. This form, however, is not practical. Modifications suggested produce the second-best results. These are both practical shapes. (2) The discharge co-efficient may be increased from 1 to 3 per cent. by substituting an efficient tail for the square one. This means a decrease of from 7 to 25 per cent. in the amount of back-water at a stream velocity of 4ft. per sec. (3) The discharge co-efficient can be increased from 5 to 6 per cent. by substituting a half-round nose for a square one. This means a decrease in the amount of back-water of from 35 to 45 per cent., with a stream velocity of 4ft. per sec. (4) The decrease in the amount of back-water obtained by substituting a 90 deg. point at the tail of the pier for the square end is negligible. The round tail is far superior to the 90 deg. point, and is almost as efficient as the 45 deg. pointed tail. (5) For piers of the same design, up stream and down stream, the half-round ends give the least amount of back-water.

MISCELLANEA.

IN Calcutta the electricity supply company is selling current at a very low rate for cooking and heating. There are great possibilities ahead in this direction on account of the hot climate.

WE are informed by the Board of Trade that Sir Archibald Williamson, Bart., has consented to act as chairman of the Committee on Electric Power, in place of the Right Hon. F. Huth Jackson, who has resigned on medical grounds, and that the following representatives of local authorities owning electric supply undertakings have been added to the Committee, viz., Mr. W. B. Smith, Mr. Harold Dickinson, and Mr. E. F. Vesey Knox, K.C.

INDIAN pig iron can be delivered at San Francisco for less money than iron can be made in the Pittsburgh district, according to Mr. Barton R. Shover, former general manager of the Tata Ironworks, Sakchi, India, but, he adds, it is not likely that Indian manufacturers of finished steel commodities will figure in the market for many years. The cost of converting iron into finished products at Sakchi is much higher than it is in America.

ELECTRICAL winding in Indian collieries has not reached the popularity attained in other countries, although there are several new pits in which winders of the plain motor-driven type with gearing have been installed. The heavy fly-wheel arrangement favoured on the Continent is not suitable for Indian coal mines. There is little doubt, says Mr. Francis Holt in the *Beama Journal*, that these winders will be a success, and that other owners will follow the lead given.

THE collieries of India, and especially those in the Bengal coalfield, have, during the past few years, been gradually adopting electricity as a motive power in place of steam. Companies owning a number of collieries have recently effected an economy by installing units at a central station and distributing electricity to the various collieries. Coal cutting machines have not made much headway, but there are several in use, chiefly of the "hammer" type worked by compressed air.

THE Controller of Coal Mines, 8, Richmond-terrace, Whitehall, S.W. 1, has issued a code of directions as to the sale of coal with a view to dealing with fluctuations in colliery prices which have recently occurred in certain districts owing to abnormal market conditions, and preserving the regularity in the distribution of coal which is so necessary at the present time. The directions mainly affect prices of coal for export and bunker purposes, for which a definite schedule of prices has been drawn up, but it also provides that the pit prices of coal for home consumption shall remain at the maxima prescribed by the Price of Coal (Limitation) Act.

A NEW cement mill, with a capacity of from 50,000 to 100,000 barrels of cement per year, has just been opened about one mile from Guatemala City by American interests, acting under a special concession of the Guatemalan Government. The plant has been under construction for two years, and involves not only the mill itself, but two miles of railway connecting with the port. Practically all the machinery was manufactured in the United States. The new company is restricted under its franchise to a maximum charge of 4 dols. per barrel for its product. The managers state that they will be able to manufacture cement at a cost of 1¼ dols. per barrel.

ELECTROLYTIC zinc works are to be established near Hobart, in Tasmania, says the *Board of Trade Journal*. It has been arranged by the Tasmanian Government to lease about 77 acres of Crown land at Risdon, on the river Derwent, to the company as a site for its works. The State Hydro-electric Department has undertaken to supply the company with energy aggregating 50,000 horse-power from the Department's Great Lake plant, of which not more than 40,000 horse-power is to be utilised in the production of electrolytic zinc. The remaining 10,000 horse-power is to be used in the manufacture of other electro-chemical or electro-metallurgical products.

A NUMBER of the best colours suitable for colouring concrete are enumerated in a bulletin on cement stucco issued by the Association of American Portland Cement Manufacturers. The bulletin states that blacks are safe, as a rule, but it is better to avoid experiments with cheap blacks. The carbon blacks are preferable to lampblacks, because they do not have the same tendency to float to the top during mixing. Ultramarine blue, if of good quality, will hold its colour for a number of years, and generally possesses the virtue of fading out evenly. It cannot be classed as permanent, as can black, brown, or ochre. Green is an unsatisfactory colour to experiment with.

THE usual report of the Council of the Royal Society of Arts announces that the Society's Albert Medal has been awarded to Mr. Orville Wright "in recognition of the value of the contributions of Wilbur and Orville Wright to the solution of the problem of mechanical flight." Silver medals for papers read during the session have been awarded to Dr. A. C. Benson, the Master of Magdalene College, Cambridge; Mr. F. A. Hocking, Sir C. Arthur Pearson, Bart., Mr. Leslie Urquhart, Professor J. A. Todd, and Captain Philippe Millet. The Society has had, despite the war, a successful and prosperous session; the financial statement showed practically no deficit; and the number of subscribing Fellows has been well kept up.

TWENTY-TWO miles of wood-stave pipe will be a feature of the new water supply for the American town of Everett, Washington, to be obtained from the Sultan River, says *Engineering News Record*. The works, now under construction, consist essentially of a low rock and timber crib diversion dam on the river, approximately 20 miles of 28in. continuous wood-stave pipe, 5 miles of 28in. by ¼in. riveted steel pipe, and 2 miles of 22in. continuous wood-stave pipe. Wood pipe will be used for heads up to 350ft., and steel and cast iron pipes are to be used above that head to a maximum of 450ft. The rate of fall in the pipe line will be approximately 1.5ft. per 1000. Wherever possible the wood pipe will be built on cradles above the ground and will be given a protective coating of water-gas tar, followed by a coat of coal-gas tar on those portions of the line where the head is less than the saturation head.

LONDON AND NORTH-WESTERN RAILWAY—LOCOMOTIVE COALING PLANT AT CARLISLE

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(*For description see page* 18)

COALING AN ENGINE

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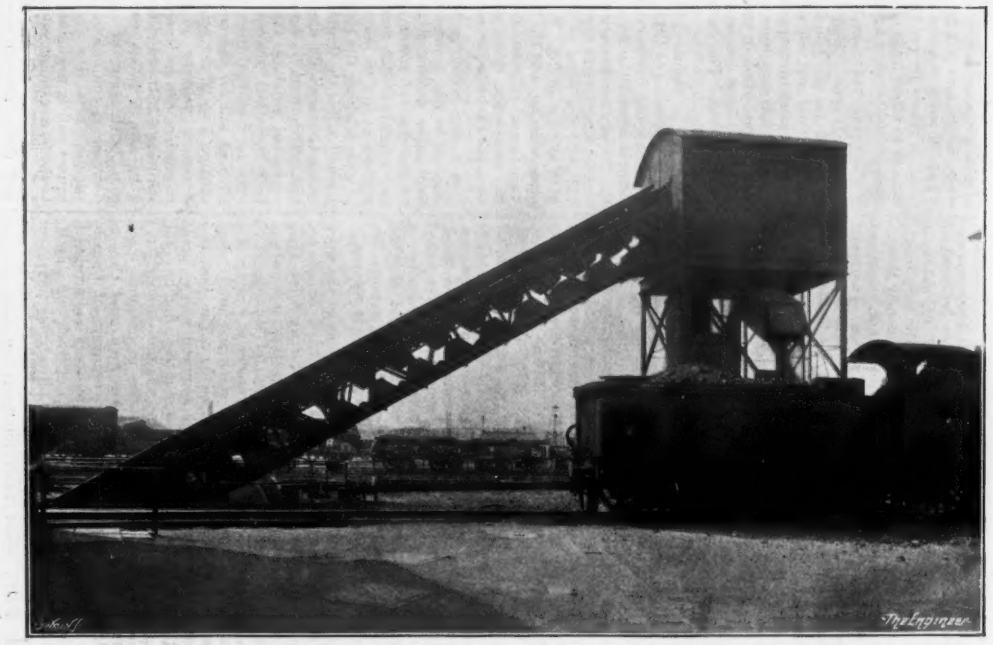

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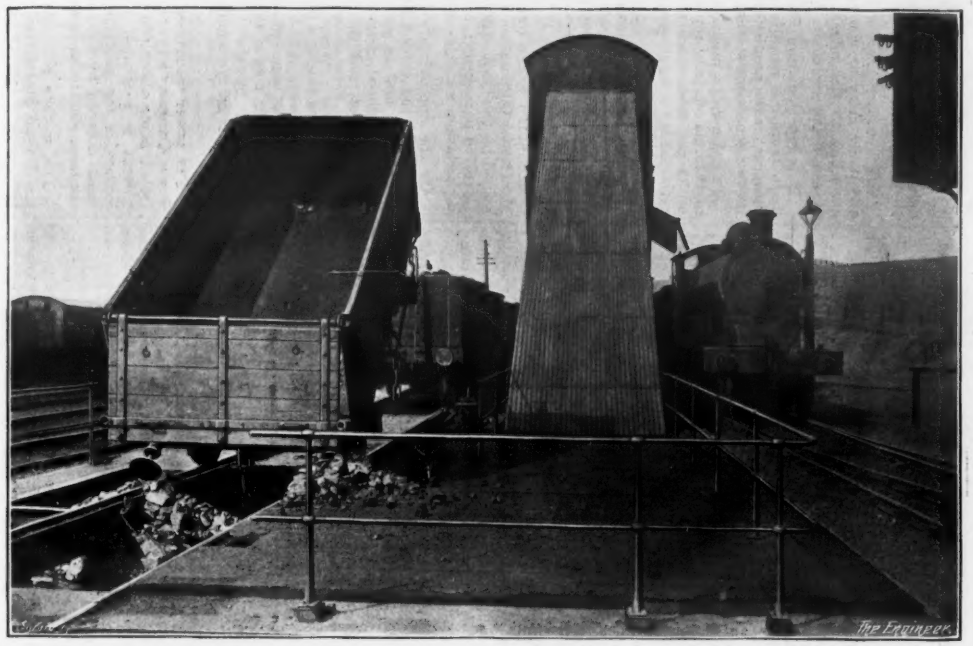

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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☛ *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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THE ENGINEER.

JULY 6, 1917.

Employers and Employed.

ONE of the most hopeful signs that industrial peace is not a chimera, not something that will for ever elude our grasp, is that on all sides there is a greater desire to compose differences than ever before. In times past the Trades Unions regarded it as their bounden duty to make trouble with their employers, and the employers on their side regarded it as one of their callings in life to embarrass the unions. The two parties led a cat-and-dog existence, because there was never any wish to be friends. A better feeling is now stirring in both. The employers are showing a real anxiety to bury old animosities and make a new charter of industrial peace with the unions, and the unions, on their side, a little coyly and nervously perhaps, are not repelling these advances, and are even going so far as to admit that they have their faults. On the other hand the employers have been busy telling each other for months past that they had mishandled labour problems, and they have manifested in a score of ways recently their real desire to amend. One disturbing factor remains. There are men called Syndicalists, whose avowed object in life is the destruction of the employer. They are the anarchists of industry, resolved to overthrow the capitalistic system, and to set up in its place a republic of industry. Against them the forces of law and order, the forces that are opposed to revolution, but not to progress and evolution, must be marshalled. Every branch of the social body can help in defeating their machinations; but none can do more, none can do as much, as the established organisations of the employers and employed. If they unite their aims, if they forget and forego old differences, if they seek to attain their common good by common means then the disruptive forces of syndicalists and agitators may be defied, and the dawn of a real industrial peace will begin.

We are no optimists on this question, but, nevertheless, we repel pessimism. That bickerings between labour and capital can be forever avoided we cannot, alas, believe, yet we are confident that a better understanding will lead to more peace than we have ever known, and we welcome every effort that is made to draw the opposing forces together in common conference. Many suggestions have been put forward within the last year or two, and they have all now centred themselves in the report just issued by the Whitley sub-committee of the General Committee on Reconstruction. This report, with unessential omissions, may be found reprinted on another page of this issue. It will be read with interest. Put in the broadest possible way the proposal is that permanent joint bodies of employers and employed should be set up for the settlement of industrial questions. These bodies would be of three kinds. First, Shop Committees, on which representatives of the employers and of their own workmen would sit. Secondly, of District Committees composed of local employers and labour representatives, and, finally, a National Council for each trade, which would be the final court of appeal below the Government. All these things have been tried in a half-hearted way already. In a fair number of shops periodical meetings between the management and representatives of the men have been in existence for years past, and we have never heard a word said against them; the District Committees resemble local conciliation boards, and the National Council reminds us of the "panels" that were established long before the war, but which were never effective. The National Council has hitherto always resolved itself into the Board of Trade; the Board of Trade means Government intervention, and Government intervention means a great crop of new troubles. It seems, as we construe the report, to be the aim and object of the Whitley Committee to keep the management of industrial affairs in industrial hands, and only to allow them, in the very last resort, to reach a Government department. That, we regard, as an admirable feature, But it must not be supposed that any one of the three bodies named is only designed to act when trouble is brewing, and it is in that respect and in their permanency that they will differ most noticeably from other machinery of the same kind. In the report will be found a list of eleven items which are regarded as "among the questions" that should be dealt with. They are without exception questions of a big kind, and it will be noticed that in many of them, if not in all, the welfare and benefit of labour is the consideration sought. Employers will not cavil at that, provided labour, on its side, shows an honest reciprocal desire for the welfare of the employer. That is an aspect all too often forgotten. It is assumed that the employer can look after himself, and we cannot say too firmly that if any such scheme as this now put forward is to succeed the action must be mutual. If the employer agrees to help labour in the various manners proposed, and often carried out of late, he has a right to expect that labour will help him, will recognise that he is an important factor in the industrial welfare of the country and will rejoice in his success.

"We are convinced," writes Mr. Whitley's Committee, "that a permanent improvement in the relations between employers and employed must be founded upon something other than a cash basis." It is the object of the machinery now proposed to provide that "something other." That it will succeed in removing the cash basis we have every reason to doubt. Since money is the basis of all industry, it is quite impossible to keep money considerations out of affairs connected with industry. The employer on his side must make a profit, and the labourer on his must earn a good wage. Unless these two factors are satisfied, then do what you will with an industry, it will never be prosperous, never contented. Utopian ideas that industrial questions can be settled ultimately on any other basis than profits and wages are bound to fail; but at the same time, even if the cash basis is inevitable, there is not the slightest reason why the traffic between capital and labour should not be conducted in the spirit of a transaction between a commercial house and a friendly client, each recognising the legitimate aspirations of the other. There are, it will be said, many industrial questions unconnected with cash. That is quite true, but on investigation it will be found that they are generally concerned with matters of the internal economy of unions, like demarcation, recognition, and the limitation of apprentices. These things have from time to time led to trouble, but in the great majority of strikes it will be found that wages or their equivalent, hours of labour, are the root cause. Whilst, however, it is impossible to escape from the "cash basis," a number of other subjects like the education of workmen, general welfare, housing, and such things as the limitation of apprentices, demarcation, the employment of women, and so on, could be profitably discussed by the suggested committees. Let us observe, finally, that recognition is tacitly admitted in these recommendations, and that they are without exception doomed to failure unless recognition implies that the accredited representatives of the unions will be supported by the members. The Trades Unions have been elevated to a high position, and the adoption of this report would put them in a still higher. Only if their leaders are strong enough to control their followers can any good result from these joint committees and councils.

The Ministry of Munitions.

THE illuminating statement made by Dr. Addison on the vote for the Ministry of Munitions is more than an account of the work of a Department of State; it is a record of the phenomenal achievements of the engineering industry and of the numerous auxiliary branches of manufacture which have come under the control of the Ministry. A good deal of criticism, much of it having legitimate foundation, has been made concerning the errors of the policy of secrecy followed with regard to what is happening in the war, whether in the field of active service abroad, on the seas, or in the workshops, which are keeping the Navy and the Army supplied with the material with which modern war is waged. This criticism was never more abundantly justified than in the case of the Ministry of Munitions, and even Dr. Addison was led to make the admission that the department which has been responsible for the industrial mobilisation of our people to meet the conditions arising from a world in arms would have shown greater wisdom had it taken the public into its confidence at an earlier date. The story of the work of

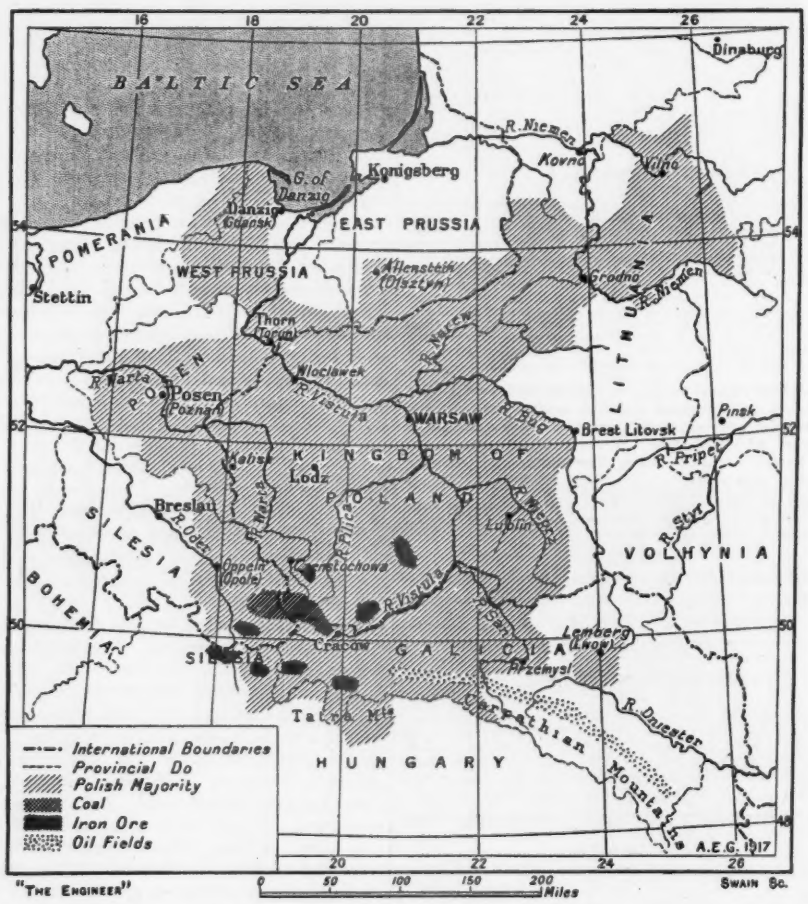
the Ministry of Munitions is in no mere conventional sense of the expression a romance of industry, and the future historian will probably date the beginnings of a new era in Great Britain as a manufacturing nation from the war tasks of the engineer and his allies in production. If what has happened in the diversion of ordinary peace activities to the manufacture of munitions, using that word in its broadest sense of constructing, equipping, and manning the many new factories which are now in operation, and of ridding the nation of the dependence for certain essential materials on foreign sources of supply, had been predicted when a beginning was made with what Dr. Addison modestly terms a "munition shop," even the most competent judges would probably have derided the idea that such manufacturing miracles were within the capacity of Great Britain. Yet the seemingly impossible has now been accomplished. Those who have read Dr. Addison's statement on the subject—engineers no less than the lay public—are filled with amazement at the results of the national effort to provide our forces in the field with the weapons without which human valour would have been in vain.

Perhaps the two facts which emerge with sharper outlines than the rest from the mass of information presented by Dr. Addison are the extraordinary capacity for production in the factories now in operation, and the wide range of activities over which the control of the Ministry extends. It is not merely the manufacture of explosives, of shells and shell components, the supply of guns of all types, of grenades, bombs, specialised chemical apparatus, trench mortars, and other materials which fall within the ordinary category of munitions to-day; the Ministry has had to deal with the supply of machine tools, scientific instruments, railway material, including locomotives, trucks, and track, road transport vehicles, "tanks," agricultural machinery, and aeroplanes, and to arrange for sea transport on a constantly increasing scale. Even this catalogue of activities does not exhaust the responsibilities of the Ministry. Before prodigies in output could be accomplished it was necessary to take cognisance of many things. These included the supply, distribution, working up, and control of the various raw materials in the form of minerals and metals, a work which has continued to grow in importance, and is giving gratifying proofs of the great potentialities of Empire sources of supply. For example, the annual output of steel in Great Britain is being increased from seven to twelve millions tons a year; the production of spelter is about to be doubled, while supplies of tungsten and aluminium from home sources are being put on a satisfactory basis. At the same time, although the main object with which the Ministry was created was to obtain the necessary large supplies of munitions, irrespective of other considerations, it has been found possible to give attention to questions connected with productive costs, and thus to effect manufacturing economies of no mean order. To quote a single instance the Ministry is obtaining steel plates at less than half their cost in the United States, and a group of T.N.T. factories is producing explosives at a cost 50 per cent. below the contract prices ruling when the factories were under construction. Then there is the labour question. Labour requirements have of course been on a stupendous scale; even in the early days there was a need for hundreds of thousands of workers, and the demands for skilled, semi-skilled, and unskilled labour have been constantly increasing. It was only possible to solve this problem by undertaking what has proved to be a revolution of our industrial system. Trade Union regulations and rules had perforce to be suspended, and a mass of semi-skilled and unskilled labour hitherto engaged in other branches of industry, or lacking previous experience of industrial life, had to be imported into munition works. The greatest innovation of all has been the widespread employment of women, who now perform most of the machine work on shells, fuses, and trench warfare supplies, and large numbers of whom have been trained in aeroplane manufacture, in gun work, and in many other branches of industry. The wonder is not that the department, under this great stress, has made mistakes, for that it has done so is admitted even by its best friends, but that these mistakes have been so few, and except during the recent strike have left the output of materials of war, by which in the last resort the Ministry of Munitions must be judged comparatively unaffected. Engineers at least have every reason to be proud of the story of their work as unfolded by Dr. Addison.

It is, however, not only the success which has been achieved in supplying the needs of the fighting forces which invests the work of the Ministry of Munitions with supreme interest, but the effect which its labours must have on the future of engineering. The experience which has been accumulated, the stimulus to production, the incentive to invention, the new spirit of self-reliance; these things are destined to have a profound effect on the industrial future of Great Britain. It is clearly impossible that we can ever go back to the methods of the past with the yawning chasm between capital and labour, and when industry was content to grope its way in semi-darkness and leave the lamp of science flickering feebly on the shelf. Men who have shown of what they are capable will never return to the deliberate practice of incapacity. We have set up new standards, and see our opportunities with a clearer vision. The place of labour in industry is receiving the careful consideration of the Reconstruction Committee, and this Committee can learn much from the work which has been carried out under the ægis of the Ministry of Munitions. It would be suicidal to disregard the lessons of the war as they bear upon our manufacturing system, and Dr. Addison will carry many with him in his belief that the nation is in a spirit to make a full use of these lessons, and of the opportunities which will present themselves in "after the war" developments.

THE INDUSTRIES OF POLAND.

In this article all those territories are dealt with which form ethnographic Poland, and which, it is to be hoped, will all be incorporated in the independent Polish State, the creation of which the Russian Provisional Government declared in its proclamation of March 30th to be one of its aims. These territories cover an area of approximately 95,000 square miles, with a population of nearly 24,000,000, and consist of the Kingdom of Poland (or "Russian Poland"), with a part of Lithuania; the German provinces of Posen and West Prussia, together with parts of Silesia and East Prussia; and the western portion of the Austrian province of Galicia, with the greater part of Austrian Silesia and a small piece of Upper Hungary. Roughly, one-half of these territories, with about 50 per cent. of the total population, constituted the Kingdom of Poland.



THE COAL, IRON AND OIL FIELDS OF POLAND

As coal and iron ore are the foundation on which the industrial development of all countries is based, and as these minerals are principally found in the western districts—where the three political divisions meet—it is there that Polish industries have made the greatest progress.

Greater facilities for transport have also had a good deal to do with the industrial development of the western territories. In 1911 the length of railways per 100 square miles of area was 9.27 miles in the Prussian districts, and only 2.9 in the Kingdom, which was in this respect far behind even European Russia, where the length of railroads for the same area was 4.2 miles. But the length available in the Kingdom for industrial purposes was even much less than that stated, as a considerable proportion consisted of strategic lines for the use of the military only.

The Polish coalfields are situated in Prussian and Austrian Silesia, the portion of the Kingdom bordering on these provinces, and in the vicinity of Cracow. They embrace an area of nearly 2200 square miles, 1168 of which are situated in Prussian Silesia, and the deposits are estimated at more than 94 thousand million tons. By way of comparison, it may be of interest to note that whereas the output of the Polish mines amounted, in 1911, to about 52 million tons, that of the French mines was less than 41,000,000. In deposits of iron ore the Kingdom is much richer than the other Polish territories, possessing, as it does, over 50 per cent. of the estimated total. A German authority, von Gliwitz, has assessed them at 300 million tons, with a probable yield in pig iron of 122 millions, but these figures are considered by Polish authorities to be a far too modest estimate.

The number of hands employed in 1910 by industrial concerns in Poland was over 1,122,000, or nearly 23 per cent. of the total number of persons engaged in all kinds of occupations. Galicia—with only about 9 per cent.—is the least developed, industrially, of the Polish provinces, whilst the most highly developed is the Prussian part of Polish Silesia, where the proportion is more than 40 per cent. It is in the latter districts that the most important German coalfields, as regards quality no less than quantity, are situated. A striking illustration of the vitality of Polish industries is the fact that, whereas the workmen employed in the industries of the Kingdom totalled 90,767 in 1877, their number amounted in 1910 to 400,922.

The mining industries employed the greatest number of men, amounting in the latter year to 216,277, of whom 154,079 were working the Silesian mines. Upper Silesia, or the Polish portion of the German province of that name, not only possesses the most extensive of the Polish coalfields, but these also yield the highest grades of coal. They give employment to 120,000 men. The coal mining industry has developed very rapidly in all the Polish territories during the last forty years, the most striking example being the Kingdom, whose output increased during that period to seventeen times the former quantity, and amounted in 1912 to 6,363,500 tons.

The iron ore industry of the Kingdom, which made surprising progress up to 1900, has since then very seriously declined, for whereas the output in that year was 484,000 tons, it amounted to only 123,000 in 1909. This decline was partly due to the crisis through which the metal industry of the whole Russian Empire passed in 1900, and partly the result of the prohibition, by the Russian Government, of the exportation abroad of iron ore from the Kingdom of Poland. An additional cause was the

introduction, by the Government, of a form of internal protection, consisting in greatly reduced railway tariffs for goods going from Russia to Poland, which made it more profitable to work Russian than Polish ore. The result was that, whereas in 1906 the iron ore mines in operation in the Kingdom still numbered 71, only 31 were working in 1909.

Zinc, lead, and copper are also worked in Poland, and in 1910 the zinc produced in the Kingdom amounted to 80 per cent. of the total for the whole of the Russian Empire. The output of zinc ore in that year was 105,098 tons in the Kingdom, and 591,000 tons in Upper Silesia.

The Galician salt mines are world-renowned, the most famous being those of Wiliczka, near Cracow, which are among the largest in the world. They occupy an area of nearly two square miles, and their resources are estimated at 21,000,000 tons.

The Polish textile industries in 1910 employed 167,881 hands. They are concentrated chiefly in the Kingdom, where they gave employment to 150,305 workpeople, while the value of their output amounted to about £3,600,000, of which total cotton goods accounted for nearly 60 per cent. In Galicia the textile industries are but poorly developed, and consist almost exclusively in the manufacture of woollen stuffs. They are almost non-existent in the Polish territories belonging to Germany, Silesia being the only province in which they are represented, and there only on a small scale.

The metal-working industries were making good progress in Poland, and gave employment to 155,439 hands, of whom 88,101 were employed in the concerns situated in the districts under German rule, and 62,027 in those of the Kingdom. These industries include shipbuilding and the construction of locomotives, in the districts situated on the Baltic (around Danzig); the manufacture of various kinds of machinery, implements, and tools, of which Warsaw and the Grand Duchy (or province) of Posen produced large quantities; and steel work for constructional purposes. Galicia manufactured machinery and plant for oilfields, of which considerable quantities were exported to Roumania, Russia, and even Canada.

A very important Polish industry, which was developing very rapidly before the war, is the manufacture of alimentary products, which in 1910 gave employment to 148,042 workpeople. Of these 84,810 were employed in Galicia, where this branch of activity represents about half the total value of the entire industrial production of the province, flour and distilled liquors being the principal products. Of the latter large quantities were exported. The most important branch of the alimentary industries—taking all the Polish territories collectively—was, however, the manufacture of sugar, which flourished in the Kingdom and in the German possessions. The output of the former territories increased within ten years by 84 per cent., and in 1912 the exports of sugar to England alone amounted to 151,000 tons, while the sugar production of the German parts of Poland amounted to 600,000 tons, or one-quarter of the total sugar output of the whole German Empire.

The Polish oil industry, which has its home in Galicia, and in 1910 employed 5449 hands, is also of great importance. The areas where this product abounds are 31 square miles in extent, and their resources are estimated at 23,500,000 tons of naphtha. In 1909 the output of the Galician oilfields was 1,043,200 tons, or 5.5 per cent. of that of the whole world.

The concerns manufacturing all kinds of building materials, as well as glass, china, and earthenware goods, were also very prosperous, and the same can be said of the chemical and other industries. Home industries are still carried on in Poland, especially by the peasantry of various districts, and of recent years societies and schools have sprung up to encourage this branch of human activity.

The foregoing will suffice to show that most of the Polish industries were making highly satisfactory progress before the war, and there can be no doubt that after it they will develop by leaps and bounds. The long-deferred realisation of the yearnings of generations will infuse new vigour into the inhabitants of Poland, whose pent-up energies will, under a national government having their welfare at heart, find expression on an unparalleled scale in every field of human activity.

The Poland of the near future will afford wide possibilities for British enterprise, which should not be missed. The exploitation of the country's mineral resources and development of its industries has but recently begun, and in many instances been seriously impeded by restrictive legislation and oppressive taxation. It is to be sincerely hoped that the hearty co-operation of Great Britain, in the industrial development of the new State, will revive the sympathies which formerly existed between the two peoples, and unite them by the closest bonds of friendship, to their mutual advantage.

THE American Society of Civil Engineers, through its Executive Committee, has abandoned the convention for 1917. This has been brought about largely by the action of the United States War Department calling for nine railway engineer regiments for immediate service in France.

LITERATURE.

Explosives. By Arthur Marshall, Chemical Inspector, Indian Ordnance Department. Second Edition. London: J. and A. Churchill. 1917. Two volumes. Price £3 3s.

In ordinary times Mr. Marshall's book, admirable as it is, would hardly have attained such popularity as to require the publication of a second edition within little more than a year of the issue of the first. It is a work for the few rather than the many, and it is a quite notable indication of the influence of the war that a book of the kind should have found so large a public. The author struck at the right moment. He provided what was needed just at the time when everyone was thinking explosives, and he deserves, and his publishers deserve, the success which has followed their energy and enterprise.

Mr. Marshall does not claim for his book that it is exhaustive, nothing short of an encyclopædia could be, but he has nevertheless provided the world with the best treatise on explosives that has appeared in the English language since 1895, when the late Oscar Guttman, author of three well-known works, published his "Manufacture of Explosives." The new edition is a good deal larger than the first, and it has for convenience been divided into two volumes, the first dealing with history and manufacture, and the second with properties and tests. The price, it may be noticed in passing, has at the same time been raised from twenty-four shillings to three guineas. A fair amount of new matter is included in these two volumes. For example, the description of French explosives and methods has been enlarged with the help of Messrs. Vennin and Chesneau's "Les Poudres et Explosifs," and more attention has been given to picric acid, trinitrotoluene, and other nitro-aromatic compounds, the supply of which "has become a matter of national importance in every country in Europe." Mr. Marshall tells us in his preface that he has "spared no trouble to make the work as reliable and useful as possible to those engaged and dealing with the explosives used in this titanic struggle." That he has succeeded in that object is proved by the ready sale for his first edition, and we need not say that the success is continued in this larger edition. Reviewing the earlier issue at some length on November 5th, 1915, we said "this excellent work should prove as interesting to the layman as it is useful to the technologist." A perusal of the later issue only serves to confirm that view.

English and Engineering. A Volume of Essays for English Classes in Engineering Schools. Edited by Frank Aydelotte, Professor of English in the Massachusetts Institute of Technology. London: Hill Publishing Co., Limited. 1917. Price 6s. 3d. net.

PHILOSOPHERS have debated the possibility of thinking without words, and have left the problem undecided. No one has questioned that thought must precede a sustained flow of intelligent language. But the two react upon each other. Clear language is the outcome of clear thought, but it is almost equally true that clear thought is the result of the effort to speak or write clearly. Writing, moreover, stimulates thought. Every intelligent man knows more than he knows he knows. Put a pen into his hand, and if he is honest with himself the thoughts will flow out of the tip of it. We say "honest with himself" because, if he is dishonest, if he slurs his arguments, if he refuses to follow his premises to their just conclusions, if he is obscure because he will not take the trouble to be plain, if he is content with an oblique sentence, then his pen will not help him at all. Rather will it hinder him by setting up a constant opposition to his loose thinking. The pen is essentially a purifier of thought, and because it makes it clearer, more transparent, new depths reveal themselves. No one can see far into murky water, and it is equally true that no one can see far into murky thoughts. For this reason it must be held that essay writing is one of the best courses of education. It will develop unsuspected powers of reasoning and observation. There is a familiar story of a professor of zoology who undertook to teach a student all about a herring. He placed the fish before the student, and telling him to write down all he could about it, left him. Returning some time later he read what had been written, told the student to write more and left him again. The intervals between his visits got longer, but the longer they got the more time the student seemed to want, for the more and more he began to investigate his subject the more and more he found new matter for study in it. New inter-relationship between the parts revealed themselves, and each succeeding essay led to the destruction of part or the whole of that which had preceded it. Moreover, the student, as he progressed, felt that his words sometimes did not express his exact meaning, or that they were capable of a double interpretation. In the effort to improve them he learnt language as well as piscatology.

Views of this kind, it is clear, influenced the editor of the collection of essays which lie before us. "There is," he says, "no profitable treatment of words that is not also a treatment of ideas. Training in expression must be also training in thought, or the result will be insincere and wordy, artificial, self-conscious; in a word, bad expression." Continuing, he says, "It is impossible to give a student any real power over language until he comes to regard language as a means for the expression of thought, and to realise that the thought is the important thing." We agree very heartily, but we should like to see the indisputable corollary enforced that since thought must proceed language the effort to produce language must encourage thought. The engineer to whom these essays are directed may say that he is to be concerned in life rather with deeds than words, and may desire to leave writing to others. Show him, however, that writing is but a means to an end, the mould in which he creates new thoughts, the tool with which he shapes them, the machine in which he tests them, and he will take a new interest in essay writing.

The idea of the volume is excellent. In America, as we have observed before in these columns, even more than in Europe, there is an ever-growing conviction that engineering is not a matter of inert materials only, but that humanity is part and parcel of it. "This book," says Mr. Aydelotte, "is built upon the theory that the function of English in technical education is twofold: in the first place to train students to express themselves in writing and speaking, not merely grammatically but with order, force, sincerity, and such charm as their natures will allow; in the second, to furnish something of the liberal humanising and broadening element which is more and more felt to be a necessary part of an engineering education." The method followed in the prosecution of this idea is the presentation of twenty-seven essays by illustrious writers, assembled in groups, entitled "Writing and Thinking;" "The Engineering Profession"—two essays by George S. Morison, an American engineer—"Aims of Engineering Education;" "Pure and Applied Science"—extracts from Huxley and Tyndall—"Science and Literature"—Newman, Huxley, Matthew Arnold, Wordsworth, and William P. Atkinson, late Professor of English at the Massachusetts Institute—and, finally, "Literature and Life"—essays from the works of Robert Louis Stevenson, Emerson, Carlyle, and John Ruskin. Anthologies of this kind, like all authologies, are open to criticism because tastes differ, but it must be admitted that Mr. Aydelotte has put before students a collection that is about as good as any other, and if they have any taste for good literature one that will not only encourage them to extend their reading but will improve their writing.

SHORT NOTICES.

A London Transport Trust. By Edwin A. Pratt. London: P. S. King and Son, Limited, Orchard House, Westminster, S.W. 1. Paper, 1s. net.—This, it is stated on the title page, is "a criticism of an unpracticable scheme;" the scheme being, we learn from the prefatory note, the setting up of what is called a goods clearing house. Despite the good case for the existing state of things made out by Mr. Pratt, it must be admitted that there is room for improvement in the way British railways handle goods traffic. Already something has been done in the increase of labour-saving appliances and methods, but much still remains to be done. Hitherto the cheapness of labour has rendered unnecessary any serious consideration of this point, but conditions are now altered, and reform in the handling of goods traffic is one of the needs of the future. The goods clearing house scheme is, as a whole, impracticable at the present time, but it has some features that call for consideration. It must do good if it does no more than stimulate thought.

Telegraph Engineering. By Erich Hausmann, Assistant Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn. London: Constable and Co. Price 12s. 6d.—This work is intended for electrical engineering students, and as a reference book for practising telegraph and telephone engineers, and for others engaged in the arts of electrical communication. It is the outgrowth of the course in telegraph engineering given by the author for a number of years at the institution with which, as said above, he is connected. The matter is wholly American, and confined principally to telegraph work, telephones and cable work not receiving that attention which the preface leads one to expect.

BOOKS RECEIVED.

Cycling Manual. London: Temple Printing Press, Limited, proprietors of *Cycling*, 7-15, Rosebery-avenue, E.C. 1. 7d. net.

The Organisation of Thought. By A. N. Whitehead. London: Williams and Norgate, 14, Henrietta-street, Covent Garden, W.C. 2. 1917. 6s. net.

Reports of the Progress of Applied Chemistry. Vol. I., 1916. Published by the Society of Chemical Industry, Broadway-chambers, Westminster, S.W. 1. 3s. to members, 5s. 6d. to others.

The Flying Book. The Aviation World Who's Who Industrial Directory and Vade-Mecum. Edited by W. L. Wade. 1917 edition. Longmans, Green and Co., 39, Paternoster-row, London, E.C. 4. 3s. 6d. net.

Department of the Interior.—Miners' Circular 23—"Elementary First Aid for the Miner," by W. A. Lignott and D. Harrington; Technical Paper 132—"Underground Latrines for Mines," by Joseph H. White; Technical Paper 142—"Vapour Pressures of Various Compounds at Low Temperatures," by G. A. Burrell and I. W. Robertson; Technical Paper 164—"Accidents at Metallurgical Works in the United States, 1915," by Albert H. Fay; "Monthly Statement of Coal Mine Fatalities in the United States, October, 1916, by Albert H. Fay; "Monthly Statement of Coal Mine Fatalities in the United States, September, 1916," by Albert H. Fay; Sixth Annual Report by the Director of the Bureau of Mines to the Secretary of the Interior for the Fiscal Year ended June 30th, 1916. Washington: Government Printing Office.

THE PROTECTION OF PARIS AGAINST FLOODS.

OUR readers will remember that towards the end of January, 1910, the river Seine rose to such a height in the neighbourhood of Paris that serious flooding occurred, and a great deal of damage was done. As a matter of fact, on only one previous occasion in history, as far as we are aware, had the river risen to a higher level, and that was as long ago as the year 1658. It will be interesting, perhaps, to give a list of the worst recorded floodings of the Seine at Paris. They are as follows :—

Year.	Height of river as shown on scale. La Tournelle Bridge. Metres.
1658	8.81
1740	7.90
1802	7.43
1807	6.70
1817	+6.00*
1836	+6.00*
1850	+6.00*
1876	6.50
1910	8.42

* On each of these years the river rose above 6 m., but did not reach 7 m. in depth as measured at the scale at La Tournelle Bridge.

Fig. 1 shows the levels reached by the floods of 1876 and 1910, with the ordinary level of the river.

So satisfied were not only the Orleans Railway engineers, but also the State engineers, that the flood of 1876 would never be exceeded, that the cills of the ventilating apertures for the Quay D'Orsay station, when it was built so as to bring the "P.O." terminus from the Austerlitz Bridge up to near the centre of the city, were only arranged at such a height as would have excluded that flood. The result was that in 1910 the station was inundated, and a vast amount of other damage was done to the metropolis. The height reached by the water during the 1910 flood, as compared with these ventilation apertures, is shown in Fig. 2.

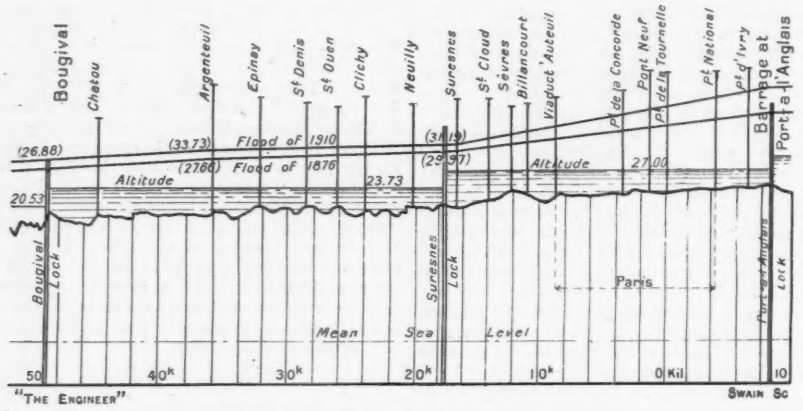


Fig. 1—DIAGRAM SHOWING HEIGHTS OF FLOODS OF 1876 AND 1910

The Parisians were anything but slow in taking the matter in hand. By February 10th, 1910, a Commission had been appointed "to determine the precautions to be taken in order to prevent inundations such as that which has just wrought such havoc in Paris and its suburbs, from being a cause of interference with, and even of stoppage of, essential public services on which the very life of the nation depends, such as means of communication—railways, tramways, posts, telegraphs, and telephones—lighting, heating, and the distribution of energy by means of gas and electricity." The president of the Commission was the late Monsieur Alfred Picard, Inspecteur Général des Ponts et Chaussées. The Commission got to work in a week, and by the following May had issued its report, a bulky document running to some 800 pages. Some few of the minor precautions it recommended were carried out before the end of 1910, but most of them—and by far the most important—still remain to be done. The whole subject is ably discussed in a recent issue of our contemporary, *Le Génie Civil*, and from that source the particulars contained in this article, as well as the engravings with which it is illustrated, have been obtained.

It is explained at the outset that though, as we have said, some of the recommendations were soon carried out, it took more than three years so to reconcile all the various interests as to arrive at a full understanding regarding the whole project. It was not, in fact, until July 16th, 1914, that the Conseil Général des Ponts et Chaussées was able to give its approval to definite preliminary work. The war came a fortnight afterwards, and prevented anything being done for the time being. On March 11th, 1915, however, M. Leboucq, Deputy for Paris, and 51 of his colleagues, deposited plans for safeguarding the Capital from flooding, and on January 13th, 1916, the Government itself brought forward the proposal for a law having the same object. The two proposals were examined by the Commission for Public Works of the Chamber of Deputies, and the report of that Commission, though handed in at the beginning of last July, was not made public till the end of the year. The Commission accepted the Government proposal, which was very much less far-reaching than was the project put forward by M. Leboucq, which embodied all the recommendations of the Commission of 1910. That Commission had, it may be explained, come to the following conclusions :—

(1) That as concerned the draining away of the floods in the Paris area, in addition to certain special measures, such as the closing of the ventilation apertures of the Orleans Railway station and the raising of certain quay walls—which, and certain other works, being considered of the utmost urgency, were carried out at once—it was necessary :—

(*a*) To repair the fender work of the Isle of St. Louis and of the Tournelle Bridge.

(*b*) To straighten out the La Monnaie arm of the river Seine, this work comprising particularly the widening of that arm in such a way as to give it a width of from 60 m. to 67 m.—say, 196ft. 9in. to 219ft. 9in.—above the St. Michael Bridge; to reconstruct the Pont de l'Archevêché, the Pont-au-Double, and the Petit-Pont; to move the Orleans railway lines further away from the river between the Pont de l'Archevêché and the Place St. Michael, and the extension of the dam in the La Monnaie channel, if not, indeed, the entire removal of that dam with its lock.

(2) That, from the point of view of works capable of reducing the intensity of floods in the basin of the Seine, and specially in Paris and its suburbs :—

(*a*) A system of underground reservoirs, with absorption pits, was inapplicable to the basin of the Seine, as was also a system of retaining reservoirs near the sources of the various streams and rivers concerned.

(*b*) The construction of a discharge channel from a point well above the city to a point well below it was technically practicable. The best line for this channel to take would be from a point on the Marne near Annet, passing through Claye, and joining the Seine at or near Epinay.

(*c*) It would appear to be possible to obtain a lowering of the maximum heights of floods, which in Paris itself might amount to as much as 1.6 m., by a general lowering of the bed of the Seine, so as to obtain a regular slope between Port-à-l'Anglais and Poses. It was pointed out, however, that such an operation as that would present many technical difficulties, such as the reconstruction, modification, or consolidation of all the bridges and other works on the banks of the Seine, especially where the city itself was traversed. It was not recommended as being a measure which would ensure general improvement.

With regard to recommendation (*b*), the Commission pointed out that such a deviation channel as was proposed might readily be made navigable, and that it would then, in addition to being a protection against flooding, furnish a means of communication between the north-east of France and the region of the lower Seine. For the prevention of flooding the channel would have to carry off a volume of water equal to 500 cubic metres per second, or just under 10,000 million gallons per day. Such a volume of water prevented from flowing through Paris in the Seine channel would, it was estimated, have the effect of lowering such a flood as that of January, 1910, by an amount varying between 1.2 m. and 1.70 m. The condition of the suburbs above Paris would, of course, be greatly improved, but below the city conditions would only be ameliorated as far as Clichy, while as for points lower down, and notably Gennevilliers, the situation would, if anything, be rather worse than it was in 1910, because of the large volume of water which would be discharged into the Seine at Epinay by the deviation canal. So as to counteract this it was suggested that the bed of the Seine should be deepened in that part of the river which envelops the Gennevilliers promontory, namely, between Suresnes and Bougival.

As regards the cost of these various proposals,

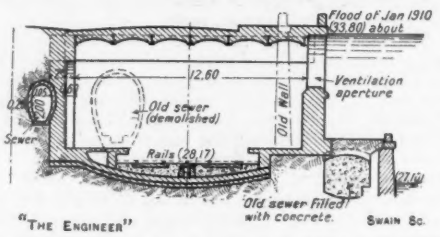
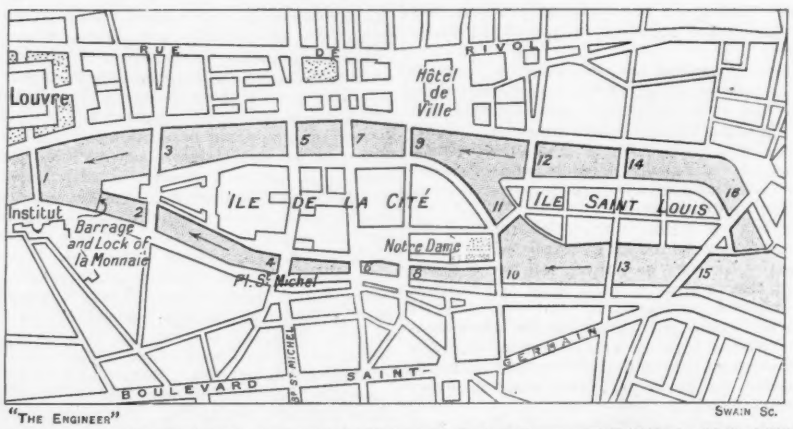


Fig. 2—CROSS SECTION OF THE QUAY D'ORSAY STATION

the provisional estimates of the Commission were as follows :—

	Francs.
The widening of the La Monnaie Channel, &c.	22,000,000
Deepening of the Seine between Suresnes and Bougival	30,000,000
Deviation of the Marne between Annet and Epinay	170,000,000
Total	222,000,000

or just under £9,000,000 sterling. The Commission made itself quite clear that though the widening of the La Monnaie Channel and the deepening of the Seine between Suresnes and Epinay might effect a considerable amelioration of affairs both in Paris and its environs, it was only by carrying out, in addition, the proposal for the deviation canal that the problem in its entirety would be satisfactorily solved. Yet, deterred, no doubt, by the high cost of the entire scheme, especially at such a time as the present, the proposals of the Government, which, as we have shown above, were brought forward in January, 1916, did not include the making of the canal. Its estimate of the cost of the other works were, moreover, in excess of those of the Commission. They were as shown below.



(1) Pont des Arts; (2) and (3) Pont Neuf; (4) Pont Saint-Michel; (5) Pont-au-Change; (6) Petit-Pont; (7) Pont Notre-Dame; (8) Pont-au-Double; (9) Pont d'Arcole; (10) Pont de l'Archevêché; (11) Pont Saint-Louis; (12) Pont Louis-Philippe; (13) Pont de la Tournelle; (14) Pont Marie; (15) Pont Sully; (16) Pont Henri IV.

Fig. 3—MAP OF THE RIVER SEINE AT THE CENTRE OF PARIS

	Francs.
Widening the La Monnaie Channel	28,346,000
Deepening the Seine between Suresnes and Bougival	39,000,000
	67,346,000

or nearly £2,700,000, as compared with the Commission's provisional figure of 52,000,000f., or £2,080,000. Though it was not included as a work which it was proposed to carry out, an estimate was given of the cost of the Marne deviation canal, *i.e.*, 261,180,000f.—say, £10,447,200. According to the Government's estimates, therefore, the whole scheme would cost some £13,140,000 to carry out, thus showing an increase of over £4,000,000; but, as we

shall show later, other advantages, in addition to amelioration in flooding, would accrue.

As regards the relative effects of carrying out the two portions of the scheme, the Government calculates that the improvements to the La Monnaie Channel, and the deepening of the river between Suresnes and Bougival, would ensure together a reduction of a possible flood by between 0.4 m. and 0.5 m., while the provision of a by-pass canal to take the flood waters of the Marne past Paris would produce a further reduction of 1 m., making about 1½ m., or, say, 4ft. 10in. in all. Apparently the Government does not anticipate the same results from the formation of the deviation channel as did the Commission, which originally proposed it, for, as we have shown above, the latter expected a relief from it alone to the extent of from 1.2 m. to 1.7 m., or, say, from 3ft. 11½in. to 5ft. 7in.

It will be remembered that right in the heart of Paris there are two islands close together, namely, the Ile Saint-Louis and the Ile de la Cité—see Fig. 3. It was on the latter that the City of Paris is supposed to have commenced its existence, and it is on it, too, that the famous cathedral of Notre Dame is situated. The two channels of the river which embrace the Ile de la Cité are not of equal size, nor do they permit equal quantities of water to pass. The smaller of the two, or the La Monnaie branch, can only pass a comparatively feeble flow, owing to the obstruction offered by the Pont de l'Archevêché, the Pont-au-Double, and the Petit Pont—see Fig. 3. Moreover, at its lower end, between the Pont des Arts and the Pont Neuf there is a barrage and a lock, which still further limits the flow of water. It was deemed to be out of the question to increase the size of the larger arm of the river—that passing to the north of the Ile de la Cité, and the Commission therefore decided that the smaller arm, the width of which at present varies between 30 m. and 80 m., should be widened so that it should in no place have a less width than 60 m.—say, 196ft. 10in. This proposal has been endorsed by the Government and by the City of Paris, and it is for this work, which it is now sought to have the declaration made that it is of "public utility." To carry it out would mean :—

(1) The removing of the salient formed by the Quai Saint Michel between the bridges of l'Archevêché and Saint Michel—see Fig. 4. This would, it is estimated, increase by nearly 50 per cent. the cross-section of the arm.

(2) The building of a new quay with a uniform width of 20 m.—12 m. being for the roadway and 4 m. for each of the footpaths—which would replace the existing quay between the Saint Michel and l'Archevêché bridges. This would necessitate the buying up of nearly all the houses which face on to the existing quay.

(3) The demolition of the barrage and lock of La Monnaie.

(4) The moving of the Paris-Orleans Railway sideways away from the river for a length of 560 m.

(5) The reconstruction of the Archevêché bridge, of the Pont-au-Double, and the Petit Pont.

These bridges would be rebuilt with a single span, and with a width of 20 m. between parapets, and they would be given such a form as would provide above the highest navigable flood a passage of 30 m. wide, giving a minimum of 4.5 m. head room, and a passage 25 m. wide, giving a minimum head room of 4.8 m. The bed of the branch would be taken down to a uniform level 4.5 m. below the crest of the barrage at Suresnes. The reconstruction of the Pont de la Tournelle, which was long ago decided upon in principle, would form part of the scheme.

As regards the deepening of the river, we understand that the river has already been given a depth of 4.5 m. below the crest of the Suresnes barrage between that barrage and the Pont Neuf, saving at some isolated points where dredging is still necessary. Deepening operations so as to reach the required limit would still have to be carried out :—

(1) Between the point where the Marne flows into the Seine near Charenton—see Fig. 5—and the Pont Neuf. This operation would mean the strengthening of the foundations of the Bercy, Austerlitz, Saint-Louis, Arcole, Notre-Dame, au Change, and Saint Michel bridges. It is intended to leave the St. Marie arm, the depth of which is 3.2 m., as it is.

(2) Between Bougival and Suresnes.

It is proposed that the existing barrages at Marly and Bezons—see Fig. 5—should be done away with. That at Marly would be replaced by a new structure erected practically at the same place, and would provide two passages, each 26 m. wide, and closed by a single balanced gate, to be worked electrically. The place of the Bezons barrage would be taken by a barrage at Bougival, which would have one navigable passage 88 m. wide. At present it is proposed that this barrage should be of the Caméré type, but it seems more probable that sluices of the Stoney type will be eventually employed.

The width of the river is also to be adjusted, so as to regularise the flow and prevent obstruction. To this end some portions of the banks, not only of the river itself, but of the islands in it, would be demolished. The total quantity of material to be removed from the Bougival reach is estimated at about 6,374,000 cubic metres—say, 8,337,000 cubic yards. It is proposed to deposit the excavated material at four points on the banks of the Seine, three of which would be at Gennevilliers and the

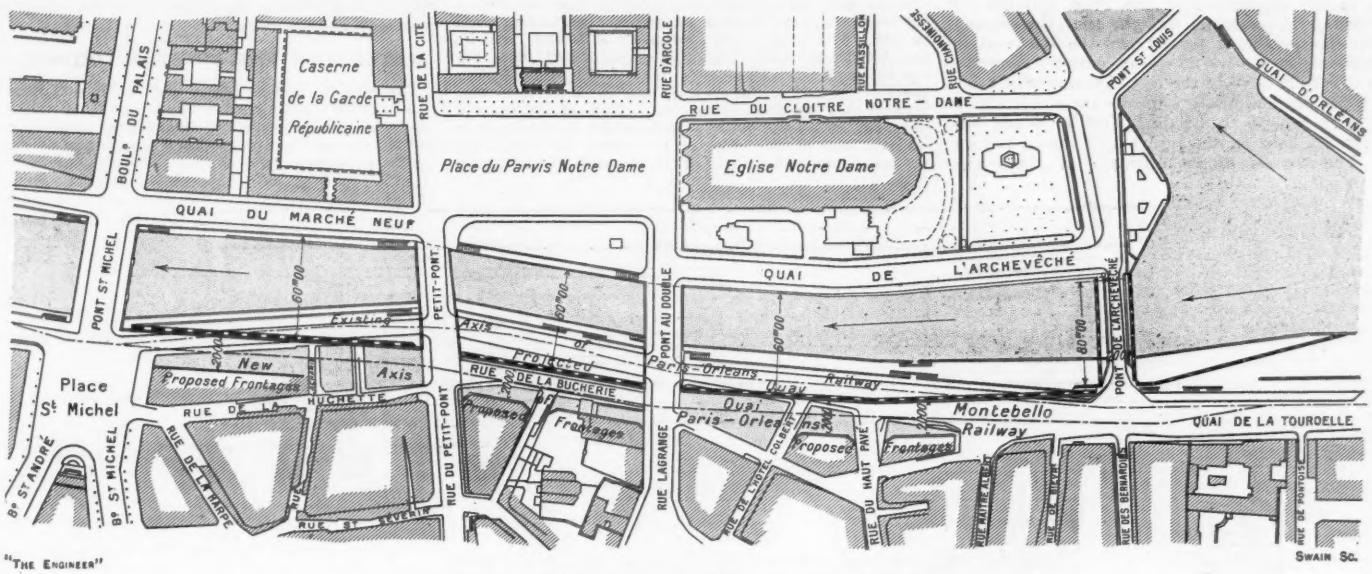


Fig. 4—PLAN OF SUGGESTED WIDENING OF LA MONNAIE CHANNEL

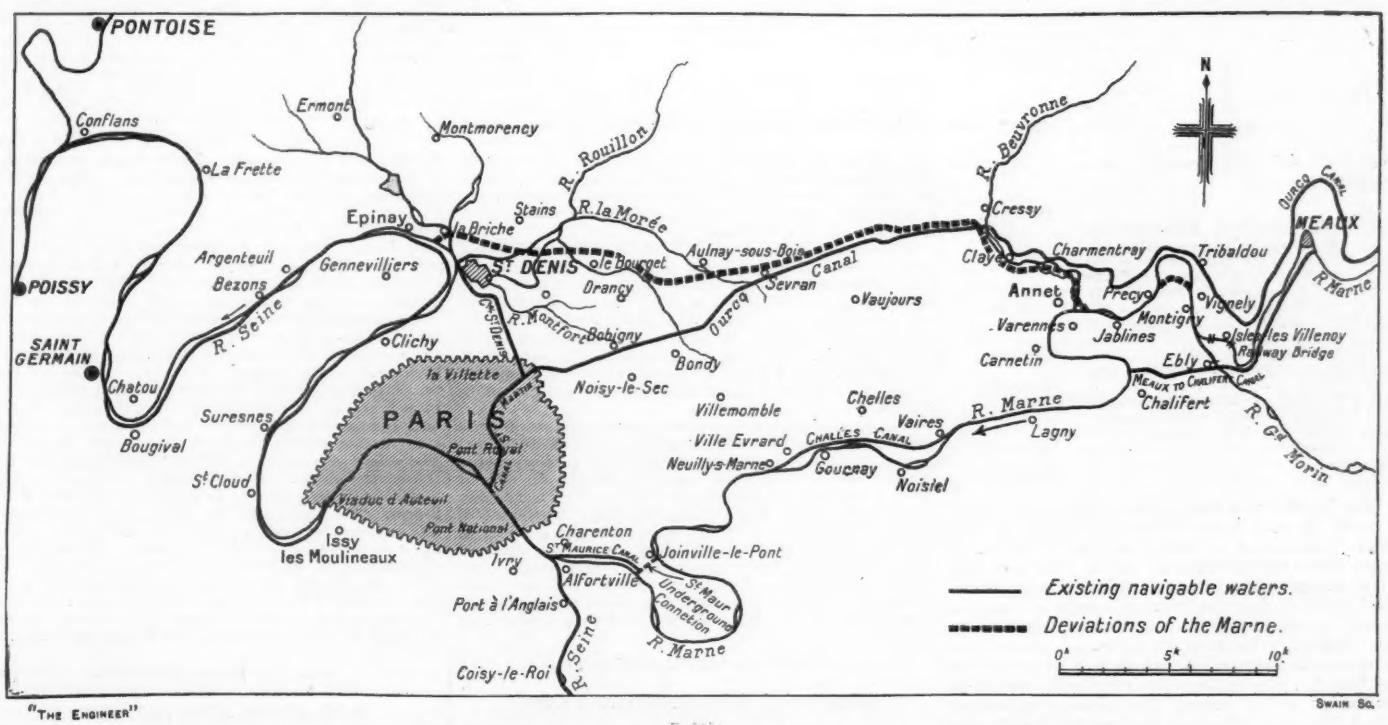


Fig. 5—SKETCH MAP OF PARIS AND ITS ENVIRONS SHOWING SUGGESTED DEVIATIONS OF THE MARNE

fourth somewhere in the neighbourhood of Achères.

It is calculated that the work of widening the La Monnaie Channel will occupy five years, of which from two to two and a-half years would be required for moving the Orleans Railway and for building the new quay wall. For deepening the river between Suresnes and Bougival it is thought that at least six or seven years, and possibly more, will be required.

It might be thought that it would have been hardly worth while to spend more than 67 millions of francs in order to obtain a possible lessening of flooding of but 20in., but apparently even that comparatively small amount would assure a considerable improvement in the navigation of the river through the metropolis. Meanwhile, though the Government has, for the time being, passed over the Marne deviation scheme, it has by no means entirely discarded it, for it is fully alive to the fact that not only would such a project materially improve the conditions of Paris with regard to flooding, but it would also considerably help on the problem of inland navigation. The details of its estimate of the cost—261,180,000f.—of this deviation and its adjuncts are as follows :—

	Francs.
(*a*) The deviation of the Marne between Annet and la Briche—see Fig. 5—including the improvement of the reach between Annet and Meaux and a deviation between Vignely and Précy	159,780,000
(*b*) The joining up of a navigable canal with that part of the deviation which is not navigable	24,000,000
(*c*) Canal making junction with the Ourcq Canal	6,400,000
(*d*) A canal from le Bourget to Conflans-Sainte-Honorine with a junction with the Oise 4250 m. above Pontoise	71,000,000
	261,180,000

It will be observed that these items cover a good deal more ground than did the proposals of the flooding Commission of 1910, and this is taken to indicate that the Government has in view not only the prevention in the future of destruction by floods in the Paris area, but the improvement of navigation, not only to the north-east of France, but also to Paris. Indeed, it is thought to be a prelude to a very extensive scheme, by which the whole of the Seine between Rouen and the metropolis would be deepened so as to permit the passage of vessels drawing 14ft. 9in. of water, the present limit being only about 10ft. 6in.

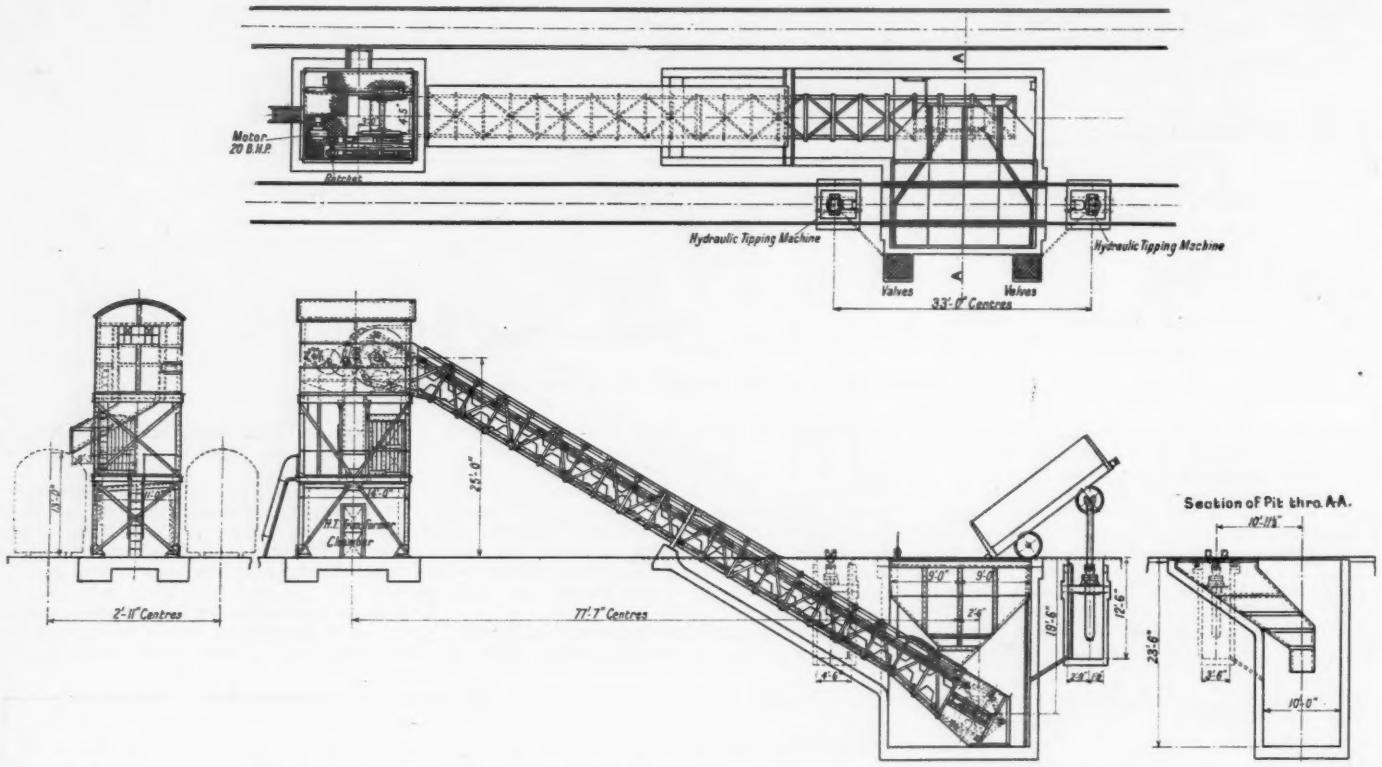
THE American Railway Association has appointed a Committee on Economics of Railway Operation. On this the *Railway Age Gazette* remarks that as an illustration of the work which will come within the province of the new committee, the establishment of an eight-hour basic day in train service raises the question on many divisions as to the relative economy of loading trains fully with the resultant heavy overtime, of decreasing the tonnage to get them over the road more nearly within eight hours, or of providing more second tracks and other facilities to reduce the delays and dead time to a minimum. The lengths of engine districts and the positions of passing tracks demand more attention.

LOCOMOTIVE COALING PLANT AT CARLISLE.

A LOCOMOTIVE coaling plant has recently been installed by the London and North-Western Railway Company at Carlisle. This plant is somewhat similar to that which is working at Camden Town, and which was described in our issue of April 2nd, 1915, but there are certain differences, some of which have been found desirable during the experience obtained with the latter plant. By the courtesy of Mr. C. J. Bowen Cooke, M. Inst. C.E., the chief mechanical engineer of the line, to whose design the plant has been constructed, we are enabled to give the drawing on this page and the engravings on page 12. It will be observed that the coal is delivered from end-tipping wagons into an underground hopper. This hopper has a capacity of 20 tons, and its foundations are taken down to a depth of 23ft. 6in. For tipping the wagons there are two vertical hydraulic rams, one at each end of the opening into the hopper, so that wagons may tip from either end. Each of the rams is provided at its top with a fork, which is designed to embrace one of the axles of the wheel, so that when pressure is applied one end of the wagon is lifted and the coal discharged from the other end. The diameter of the hydraulic rams is 6in., and the length of stroke 6ft. 10½in. The hydraulic pressure used is 2000 lb. per square inch, so that the total upward pressure obtainable is something over 25 tons.

From the hopper the coal is lifted by a chain of fifty-six buckets, each of which has a capacity of one-third of a ton. The height of the centre of the chain drum over which these buckets travel is 25ft., and the depth below rail level of the centre of the lower chain drum is 19ft. 6in., the distance between the centres of these chain drums being 77ft. 7in. The coal, as it is lifted, is discharged from the buckets into a shoot arranged to come immediately above the tender of the locomotives which have to be coaled.

The chain of buckets is driven by a three-phase 50-cycle motor, supplied by the British Thomson-Houston Company. This motor works at a speed of 565 revolutions per minute and a voltage of 400. It obtains its current from a high-tension transformer contained in a chamber immediately below the working platform. The speed of the motor is reduced by three sets of spur gearing, so that the speed of the shaft which drives the chain of bucket is about 1.6ft. per minute. This means that eight buckets are discharged per minute, and that some 150 tons of coal are dealt with in the hour. The plant was constructed by Cowans, Sheldon and Co., Limited, of Carlisle.



LONDON AND NORTH-WESTERN RAILWAY—LOCOMOTIVE COALING PLANT AT CARLISLE

AMERICAN ENGINEERING NEWS.

DRAINAGE OF IRRIGATED LANDS.

In much of the irrigation of arid or desert lands in the United States, it has been found that the application of water tends to a water-logged condition of the soil, especially where it is applied in excess and where the soil is of a character to retain water. It also results in a concentration of alkali salts, which are detrimental, if not even destructive to growing crops. On many large irrigation projects, therefore, it has been necessary to drain the land, to prevent its being rendered useless by too much water, as it was formerly made useless by lack of water. In other cases drainage has been provided in advance of irrigation. An instance of the latter procedure is afforded by a 10,000 acre tract of land in Utah, which has been put under irrigation by the company owning the land and arranging to sell farms to settlers. A complete system of tile drainage has been put in, arranged mainly on a gridiron plan, with lines of drains 450ft. apart. The tiles are 5in. to 12in. diameter, laid in trenches 4ft. to 7ft. deep. Three trenches were excavated by three excavating machines of the wheel type, each operated by a 75 horse-power petrol engine. The machine travels on caterpillars or wheels, and carries at the rear a huge circular frame on wheels, supported on a jib, which is pivoted to allow of raising or lowering the wheel for the desired depth and gradient. Buckets and knives on the revolving rim excavate the earth and deliver it upon a transverse belt conveyor, which throws it clear of the ditch. A steel casing behind the wheel prevents the sides from caving in, and forms a protecting cab for the man who lays the pipe. The filling is done by long plank scrapers with a pair of teams. The machines dig 1600 to 2400 lineal feet of trench in ten hours, the trench being 20in. wide and 7ft. deep.

WATER-TUBE FIRE-BOX FOR LOCOMOTIVES.

THE New York, New Haven and Hartford Railroad has two locomotives equipped with the McClellon water-tube fire-box, which is designed to eliminate the use of stay-bolts and to provide for expansion and contraction by dividing the fire-box into a series of units. Individual units can be renewed with little trouble. Staybolts are used, however in the foundation ring space, which is a chamber 6in. by 7½in., extending around the sides and back of the fire-box. Vertical tubes 6in. diameter extend from this chamber to a pair of 23in. horizontal drums, between which is a 32in. drum. These drums form the top of the fire-box, and have flattened contact surfaces which are welded together. They are 12ft. 6in. long, with the front ends opening into the boiler barrel, the shells of the drums being pressed to conform to the outline of the top of the barrel. The rear ends of the drums are also de-formed to provide for receiving the 6in. tubes which form the back-head of the fire-box. The side and back tubes at the corners are riveted together In front of the fire-box proper is a semi-circular combustion chamber formed by 5in. tubes attached to the sides of the outer drums and to a circulating chamber beneath the rear end of the barrel. The safety valves and whistle are attached to the top of the central drum. All the vertical tubes are expanded and belled into both the foundation ring space and the drums. The boiler has 167 tubes, 2¼in. diameter, and 30 superheater tubes, 5½in. diameter. The fire-box has a cement lagging and steel jacket. The engines thus equipped are of the 2–8–2 type, weighing 120 tons. They have 308 square feet of fire-box heating surface and 2937 square feet of tube heating surface, as against 229 square feet and 2827 square feet for other engines of the same lot, but having ordinary fire-box construction.

NEW SCREW-CUTTING DEVICE.

A NEW screw-cutting device, the patent of J. D. Carver, has been introduced by Messrs. W. D. Wansbrough, Skelsey, and Gunther, of Exchange-huildings, Birmingham. The apparatus consists essentially of a steel block or tool-box, carrying seven or more tools which are stepped, and are spaced a certain number of pitches apart. This is attached to the compound rest of any existing screw-cutting lathe, and a stepped plate, or guide, corresponding to the position of the tools, is used in connection with it. A stop attached to the cross slide of the lathe is held in contact with the step by the operator's pressure upon the cross feed handle. The effect of this is that when the saddle is started by being put in gear with the lead screw, each of the seven tools successively traverses over the work, and then takes a step to the rear, thus avoiding the shoulder or collar. The stepped plate is kept from moving longitudinally by a bar, jointed to a projecting pin clamped to

the lathe bed by a bracket. The thrust is taken by a plate secured to the front of the saddle. The saddle only moves over to cut the full thread, and is returned to the starting point again by the operator, the step-plate lifting to allow the stop to pass, the edges of stop and step-plate being bevelled off for that purpose. An adjustable stop is used as an alternative to the fixed stop, so as to allow of small adjustments affecting the diameter of the work to be easily made.

The device is not put forward as universally applicable; it is only useful where the length of thread is short relatively to the diameter. In such cases, it is claimed, the operation of screw-cutting is greatly reduced in time and cost. For example, a 2¼in. by ¼in. plug of 26 ton steel can be screwed up to a shoulder in 10½ seconds. We understand that the proposal is to grant licences to use the device.

THE W. R. COMBUSTION INDICATOR.

In the article describing the "W. R." Combustion Indicator, which was published in our last issue, we inadvertently stated that the instrument was manufactured by Holdsworth and Sons, Limited, of Bradford, who had drawn our attention to it. It is made by the inventor and patentee, Mr. H. R. Webster, of Scotland-lane, Horsforth, near Leeds.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions of our correspondents.)

COPPER TUBES FOR AEROPLANES.

SIR,—Let me comment briefly on the notice given in the issue of June 17th of THE ENGINEER, relative to the standardisation of copper tubes for aeroplanes.

Much has been said lately about standardisation, which has often been claimed as the only way for increasing war production. Nevertheless, very little has been done, on account of the difficulty of such an enterprise hampered in all the countries by the extra rapid development which affects in the course of a few months practically all the parts of a machine.

I believe it would be much better for each constructor to study the possibility of reducing to a minimum the varieties of parts in his own type of machine.

A step in this direction must logically precede every attempt at general standardisation. It happens on the contrary that when a campaign for the latter purpose is carried on by the leading constructors, the greatest number of machines still in construction is far from realising that "internal uniformity" which might, as a matter of fact, overcome more speedily a great number of those difficulties which are now interfering with the efficiency of the aerial services at the front.

Let us consider, for instance, a standard 250 pusher biplane of 1916 type, still in use in all the allied countries. The analysis of the drawings reveals the following astonishing features:—

Varieties of metallic pieces	350
,, of steel tubes	22
,, cables and wires	10
,, wood employed	9

From these figures the motor and its accessories are excluded.

The same analysis relative to various well-known tractor fuselage machines now under construction, having the same power and carrying capacity, reveals a reduction of the above figures from 20 to 30 per cent.; reduction due chiefly to the fact that fuselages are now often of wood construction, and the general dimensions are somewhat reduced.

A careful analysis of standard up-to-date machines demonstrates that the great majority of designers are unable to appreciate the practical advantage of reducing to a minimum the varieties of parts, and reveals only the greatest care for reducing air resistance and weights. A few—extremely rare—exceptions, fortunately, show on the contrary what may be obtained by valiant designers who have, together with an excellent aerodynamic knowledge, a good experience of practical construction and *working costs*.

Reductions from 30 to 60 per cent. in the varieties of parts were obtained merely by increasing by only a few pounds the total weight of the machine, whilst leaving the head resistance, the factor which influences to the extent of eight-tenths the efficiency of a modern high-speed machine, unaltered.

The same principles applied to a commercial low-speed machine would lead logically to an increase of the head resistance, as it is well known that in low-speed machines the importance of weight as a factor of efficiency is considerably higher than that of head resistance.

In conclusion, I desire to say that in my opinion standardisation ought to be initiated in the interior of the single machine. Facts demonstrate the possibility of reducing by about 50 per cent. the varieties of parts in the majority of modern aeroplanes. Such "uniformisation" involves but little increase in weight or resistance, and means, practically, a diminution of about 30 per cent. of the labour cost, and of 40 per cent. in the time required for erecting the machine.

ING. CARLO MAURILIO LERICI,
Aeronautical Engineer of the Società SIA
(F.I.A.T.), Turin, Italy.

Turin, June 24th.

THE CONQUEST OF SCHLESWIG-HOLSTEIN.

SIR,—The article in your issue of the 22nd inst., on the German dockyards, stated that the conquest of Schleswig-Holstein was made in the year 1864. I believe that Schleswig was then added to the previous conquest of Holstein by the Prussians during their war against Denmark in 1849 or thereabouts.

I was at a boarding-school in Eppendorf, north of Hamburg, in 1848 to 1850. At that time the Germans had as yet no navy. The Elbe was blockaded by three Danish frigates. The only British steamer permitted to reach Hamburg was a mail steamer from London. The three lines of steamers trading between Hull and Hamburg being jealous of this preference, each got a bag of letters from the Post-office, and three steamers arrived from Hull together off Heligoland. I was on board one belonging to Mr. Joseph Gee—returning to school from holiday. A cutter approached and informed our captain that we could not proceed further, so we anchored and landed on that British island, where a sailing vessel—employed in supplying Heligoland with turf for fuel from Germany—was chartered to convey the passengers to Cuxhaven; we arrived there at the same time as the mail steamer from London, to which we transhipped, and in due course reached Hamburg.

In Hamburg we found the Prussian troops, who were equipped with the new needle guns and Pickelhaube helmets. I frequently saw these troops exercising in the country near my school.

A Danish squadron was driven off the coast by German artillery at Eckernförde, north-west of Kiel, and the final result was the conquest of Holstein, if my memory is not at fault, now in my eighty-fourth year.

You are not alone in your assertion that the German and Austrian War against Denmark was in the year 1864, whereby both Holstein and Schleswig were conquered, as I have noticed the same in previous recent publications. I should be glad if a corroboration of my above assertion could be found. Kiel is in Holstein.

T. FEWSTER WILKINSON.

July 2nd.

A SECRET SESSION FOR ENGINEERS.

SIR,—I have awaited with some hope, though latterly I must confess with little expectation, the appearance in your columns of numerous letters supporting the suggestion made by your correspondent, "C. E. H.," in your issue of June 8th. The hope, however, has been in vain, and the doubt realised. Obviously, Mr. Petter is a very suitable person to call the special meeting suggested by your correspondent, could he see his way to afford the necessary time and talent; but, equally obviously, it is absurd to expect Mr. Petter, or anyone else, to take action unless he is assured of a reasonable amount of support.

The matter rests with the individual members of the profession and concerns their interests in particular, as well as those of the profession and the country in general. It is therefore incumbent on every member sharing the views so far expressed by your correspondents, to take action and do his utmost to promote the reform he desires.

I am afraid, however, that the absence of interest displayed hitherto in this discussion goes to show that, with true British complacency, the mechanical engineers of this country are content to leave their interests to be controlled by hopelessly inadequate methods. One is thus reluctantly compelled to conclude that, as a body, they have neither the initiative nor the "grit" to make a place for themselves suited to the importance of their profession, and that the inept control under which they languish is but a true reflection of their own lack of virility.

To be a "Britisher" and compelled to admit such a state of affairs is humiliating, but there are available to-day too many evidences of the prevalence in various directions of the *laissez faire* policy to disguise the unpalatable truth.

It is not that men of foresight and vigorous ability are lacking, but that the narrowness of outlook, reluctance to discard obsolete methods and ideas, and love of compromise, characteristic of the English temperament, produces a degree of inertia, which all the energy of those forceful men, whom we do possess, seems powerless to overcome.

H. C. C.

London, July 4th.

CATALOGUES.

JOHN TULLIS AND SON, Limited, Glasgow.—Illustrated pamphlet describing and giving prices of Tullis Laminated Belting.

GEORGE F. WEST AND CO., 13, Victoria-street, Westminster.—Booklet illustrating the machinery for excavating and handling rock earth and stone.

R. MARTENS AND CO., Limited, 15A, Wilton-street, Grosvenor-place, London, S.W.—Illustrated priced catalogue of Clydesdale commercial chassis.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Limited.—Special Publication 7855/1, "The Control of Motors for Industrial Work."

THE Sullivan Machinery Company.—Bulletins 71 C and 75 B, illustrated pamphlets, describing the Sullivan air lift pumping system, and the Sullivan straight line air compressors respectively.

ROBEY AND CO., Limited, Lincoln.—Catalogue No. 244. An exceedingly well illustrated and arranged booklet descriptive of the traction engines, road rollers, tractors, &c., made by this firm.

THE Spray Engineering Company, of Boston, Mass.—Illustrated catalogue of spray cooling, air washing and cooling, and paint spraying equipment; park sprinklers, flow meters, and nozzles for all purposes.

THE British Reinforced Concrete Engineering Company, Limited, of Manchester.—Illustrated catalogue showing numerous applications of the B.R.C. system of reinforced concrete construction.

THE Sturtevant Engineering Company, Limited, London.—Illustrated leaflet describing the firm's new automatic bag filter, which is claimed to be of special service for the recovery of valuable or other dust in a dry state.

ATELIERS DE CONSTRUCTION OERLIKON, Oerlikon, Switzerland.—Communications Périodiques: No. 84, "Frein Electro-magnétique Agissant sur les Rails"; and No. 86, "Eclairage Electrique des Trains Système Oerlikon."

THE Consolidated Pneumatic Tool Company, Limited.—Catalogue No. 8 E. Illustrated descriptive pamphlet dealing with drills for metal, rock, &c., air compressors, grinders, coal and ore borers, hammers, blowers, couplers, &c.

THE British Thomson-Houston Company, Limited.—Descriptive list No. 3265, giving illustrated specifications of motor control panels, and Descriptive List, No. 10,479, an illustrated pamphlet descriptive of industrial fittings for half-watt type lamps.

THE General Electric Company, Limited.—Illustrated descriptive leaflets: V. 2088, "Wilton" Moulded Insulation Terminal Blocks; No. L 2093: G.E.C. Haulage Road Signalling in Collieries; and O 2104 (Supplement to Bulletin No. 8). The "Kingsway" Miners' Electric Hand Lamp.

THE Cambridge Scientific Instrument Company, Limited.—List No. 134: An illustrated description of "The Cambridge Measuring Microscope for Workshop Use." List No. 151: Illustrated description of "The Cambridge Flow Recorder," for recording the volume of gas or air passing through a pipe. Leaflet No. 912: Illustrated description of recording and index thermometers. List No. 191: Illustrated description of "The Cambridge Thermo-couple Potentiometer."

FROM Wm. McKinnon and Co., Limited, Spring Garden Ironworks, Aberdeen, we have received a handsome and interesting catalogue dealing with cacao-curing machinery. Like the same firm's catalogue of coffee machinery, which we received some months ago, this publication is almost as much a work of reference as it is a catalogue. It should prove of great interest and value to the cacao planter who may be contemplating the adoption of modern methods and machinery on his estate in place of the commonly primitive practice still frequently followed in many instances. With the working up of the cacao into cocoa and chocolate it does not primarily set out to deal. But even to those interested in this side of the industry the catalogue will, we think, be welcome.

H. W. WARD AND CO., Lionel-street, Birmingham.—We have received from these makers a copy of the pocket edition of their catalogue of capstan and turret lathes, small tools, and attachments. It is an admirably produced book, printed in small but clear type, and very well illustrated; but the feature that appeals to us most is that it is virtually a handbook of the machines dealt with, as it gives a good description of each one, the parts being shown separately, and where necessary in section, and marked with identification letters. H. W. Ward and Co. tell us that, as they are anxious that foremen, tool-setters and operators should have copies of their handbook, they will forward them to anyone on receipt of a letter giving the name of the firm by whom the applicant is employed.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Manufactured Iron Price Situation.

THERE is continuous activity at the bar mills. An unusually large proportion of high grade iron is being made. It is understood that the question of applying to the authorities for an advance in the controlled prices of bars, in consequence of the rise in the pig iron maximum, is now regarded as one for the consideration of the national organisation, rather than for local action. No move has been made yet, so far as appears. Whether the other districts of the kingdom will join with the Staffordshire ironmasters in taking action is uncertain. It is important to remember that South Staffordshire part-mine pig iron, which has been advanced 5s. per ton, probably does not enter into the composition of unmarked bars to a larger extent than one-fourth, and in best bars the proportion is even smaller. As the pig iron named is the only denomination to which the advance authorised by the Ministry of Munitions applies, it is evident that the effect on the finished iron trade is greatly modified. The only advance which has at present occurred attributable to the new rate for raw material is in small rounds, which are now quoted on the basis of £16 15s. for three-eighths size. Whether the time is considered opportune for abolishing the discount of 2½ per cent. on Staffordshire marked bars, and so giving full effect to the movement for net prices, is a question somewhat apart. The general market position may be described as that where the Government "control" operates all prices are at the maximum, and in the uncontrolled branches prices are subject to wide variation, with a just perceptible upward tendency. Much depends upon the engagements of individual makers, the capabilities of rolling mills, accessibility of suitable raw material, and other circumstances. If they could secure deliveries, many consumers would be willing to give almost any price for rolling mill products to-day. So little do considerations of cost enter into many transactions that it is no uncommon thing, indeed, for would-be buyers, at the present time, to send particulars of their requirements to ironmasters, or merchants, leaving the seller to fill in the prices.

Market Prices.

Staffordshire marked bars keep at £15 10s. to £16 10s., merchant bars £15 to £16, and common bars £14 10s. to £15. Small rounds command £16 5s. and upward, quoting on the three-eighths basis. The hardening tendency in this branch is not arrested. Steel rounds make up to £17 10s. Nut and bolt bars are quoted at prices substantially above the official maximum for merchant bars. There has been no change in consequence of the enhanced cost of South Staffordshire pig, to-day's rates being £14 5s. to £14 11s. 3d. delivered in the district. The consumption of this class of iron is on a large scale. It is very difficult to obtain puddled iron on the open market. Something like 20 per cent. of the furnaces are idle for want of puddlers. Lately, output has been assisted to some extent by the cool weather, but it falls far short of demand. Such puddled bars as change hands realise about £12 5s. The sheet iron trade is without improvement, and prices remain at £19 10s. for black sheets of 24 w.g., and galvanised sheets are £28 10s. to £29 10s. for export and home respectively.

Pig Iron.

The demand for pig iron tends to increase, but large furnaces are to be started shortly, which will considerably increase the output. The effect already has been to stimulate the coke market, in view of the larger amount of fuel called for. A great deal of iron has been sold recently, and having regard to the congested state of their order books smelters are now limiting new commitments. Foundry iron, Nos. 1, 2, and 3, are specially active. The output of the furnaces is going into consumption almost as quickly as it can be distributed. Having taken stock of the situation, smelters are not disposed to make sales of any magnitude. They prefer to keep the market going from hand to mouth, present commitments against prospective output being heavy. Plenty of producers have nothing to sell. Prices are:—South Staffordshire: Common forge, 95s.; part-mine forge, 100s.; foundry, 102s. 6d.; all-mine forge, 115s.; foundry, 120s.; warm-air forge, 145s.; foundry, 155s.; special quality—Lord Dudley's cylinder—167s. 6d.; cold blast, 182s. 6d. North Staffordshire: No. 4 forge, 95s.; foundry numbers, 97s. 6d.; basic, 97s. 6d. Northamptonshire: No. 4 forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry, 94s.; basic, 97s. 6d.

Steel.

Raw steel consumers report a continuation of shortage in supplies. Prices are also further rising. No increase has occurred in American deliveries of semi-manufactured bars and billets, greatly to buyers' disappointment. It had been thought America's entry into the war would have released tonnage for conveying much needed supplies. American billets are quoted at £20, to which transport charges must be added, compared with £10 7s. 6d., the British fixed price. American wire rods are £28 to £30 delivered this side. Discard steel can now only be dealt in under priority certificates, which means a further curtailment of the general trade.

The Engineering Trades.

The demand for machine tools is very active, though the orders now being placed are not of such dimensions as those which kept the industry working at high pressure during 1915–16. The smaller types of lathes are called for in large numbers. Makers of heavier types of tools are also well employed, overtime being the general rule, with night shifts in some departments. Considerable comment has resulted from the Government announcement to the engineering trades that machine tools and plant of that description, either new or old, must now not be transferred from premises where

they are at present without the sanction of the Ministry of Munitions. This is interpreted as extending the "control" to innumerable small machines which are not of such a value as to have brought them within the scope of previous orders. Machinists state there is nothing in current business to warrant the new order, which will hamper trade and be troublesome to buyers and sellers alike. The system by which the home output and the imports of machine tools have been allocated to the national cause is so complex that it has threatened to defeat its object. A little while ago a scheme of devolution was decided upon. Clearing-houses were opened in certain provincial centres, including Birmingham, which have done something to overtake arrears. Complaints have not ceased, however, that machines which are awaiting for customers are kept out of service while sellers are authorised to deliver. Birmingham manufacturers report with satisfaction that the official hold upon copper has been relaxed slightly of late. Some copper sheets have been released for the manufacture of various articles which the public are in want of. This has been rendered possible by the accumulation of certain categories of munitions whose supplies of raw material had to be safeguarded. The price of copper sheets has settled at £165.

Excess Profits.

The Coventry Chamber of Commerce has this week urged the Chancellor of the Exchequer "to accept amendments to the Finance Bill which will remedy the existing law, and enable taxpayers who made increased profits in 1914, before the outbreak of war, even though their accounting period ended after August 4th in that year, to have such profits taken into consideration in arriving at their pre-war standard, and so remedy an injustice that threatens the very existence of some firms."

The Chain Trade.

All the branches of the Black Country chain trade are kept working at high pressure. The extension of the shipbuilding programme is making heavy demands upon those branches which have to do with the highest class of chains, as well as upon anchor-smiths. The pressure is all the more marked, inasmuch as the ranks of the workers have from one cause and another been greatly thinned since the war began.

LANCASHIRE.

(From our own Correspondent.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE iron and steel markets are without any animation, and there is very little to be done outside war work. Of course, interest in the markets is very much diminished, and cannot well be revived until the speculative element is again allowed some freedom. That is not likely to come about until the war is ended; and even then it may take some time to recover the lost liberties of trade, although it is certain that a strenuous effort in this direction will be made.

Forge Pig Iron.

The feature of this market is the abundance of forge iron in the Cleveland district, which is a little difficult to understand. According to reports this class of iron is now being sold up in the North at something less than the maximum, and it is the only iron for which the full limit cannot be obtained. Of course, it has to be remembered that for some obscure reason, appreciable only by the official mind, the maximum for Cleveland forge pig has been fixed at the same price as that of foundry pig, viz., 92s. 6d. per ton at the furnaces, or 2s. 6d. more than for the same quality of iron at a Midland furnace. Possibly this has caused furnace owners to make more forge iron than was needed, or at any rate to be indifferent as to whether the iron came out No. 3 foundry or No. 4 forge. Here there is no very apparent demand for forge iron, but a good deal of this business is done direct between the iron manufacturer and the ironmaster.

Foundry Iron.

The demand for foundry iron here keeps up, and the supply is only small, but, of course, prices cannot now be affected by this situation. There is, however, a certain inconvenience to consumers resulting from the fact that prices are fixed, for the natural tendency of sellers is to look after their best customers, and leave the others to do what they can. In ordinary times, of course, these others could always obtain what they wanted by paying a little more, but now they are precluded from doing this; and if the supply of iron should be further reduced these people may find themselves awkwardly situated. The fixed price is all very nice from the consumer's point of view, so long as there is plenty of material to go round; but the position is obviously very different for the consumer should he wish to compete with others for a limited supply. Derbyshire No. 3 foundry iron was quoted at the old price of 98s. 8d. per ton delivered and including a merchant's profit, and North Staffordshire at 102s. 6d., and at both these prices, which are a little absurd when considered in relation to one another, there is no difficulty whatever about selling all the iron which makers offer. Merchants indeed would be glad to get hold of more iron if they could. About No. 1 Midland iron one does not hear much just now, and as the sales of Scotch iron seem to have improved lately it is possible that there is not enough No. 1 to satisfy the requirements of the district. The Scotch prices remain at 126s. 6d. for the lower group of brands, and 128s. for the higher group delivered free, but subject to a merchant's profit of 1¼ per cent., if the sale is not made direct. It is dear metal for the Lancashire founder, and is bought only under pressure of necessity. There is no Lincolnshire foundry iron offered here now, and it is said that none is being made, the furnaces having been put upon basic. Some small lots of Cleveland iron are sold occasionally, but at higher prices than Derbyshire, and practically Cleveland is out of this market.

Semi-steel.

The market was altogether without supplies this week, and foreign material was not even quoted tentatively. The nominal English price of billets remains unchanged, but like many other authoritative prices, it bears no relation to the actual situation.

Scrap.

There is quite a good demand for foundry scrap, and prices are firmly held, but there has been no further advance, and, in fact, the market is now quite high enough. Even if there were an opportunity of putting prices up, I question whether it would be wise on the part of dealers to do so. They do not want any interference with this market, and while they are content to work on moderate prices and for moderate profits they ought not to be interfered with. For the best qualities of spinning machinery scrap 112s. 6d. to 115s. is asked, and the use of this to improve the quality of castings saves some 12s. per ton, as against the use of Scotch pig iron. For common qualities of scrap 105s. delivered is the price. In wrought scrap there is nothing being done, except the deliveries against old contracts. New business is impossible under the regulations, and the time is coming when they must be revived if the trade is to go on. Consumers who have no contracts are already awkwardly placed, and no doubt they regret having backed up one of their number in his attack upon the old prices. Some heavy steel melting scrap is being sold at 105s. on trucks, plus 2½ per cent., and the demand for this material from South Wales continues, but none goes to Sheffield, and the Cleveland inquiry has also ceased. There is, however, a local demand, and the supplies are not very large. For steel turnings there is an inquiry, but they cannot be bought here at the limit of 50s. set by the authorities.

Metals.

Copper is unchanged; strong sheets nominally at £165. Tin has been a little easier, and English metal has been offered here at £256. Lead is not quoted Old gun-metal is in demand, and over £130 per ton would have to be paid for a good quality.

New Works in Manchester.

In this column I recently called attention to the numbers of new works and extensions which are being erected by engineering firms in this district. One of the most prominent of these is at Erwood Park, on the London and North-Western Railway, between Levenshulme and Stockport. At this place the firm of Crossley Brothers, Limited, has acquired some 50 acres of land in close proximity to the road and railway. New roads have been laid out, and a fine block of buildings, some 300ft. square, has been erected, together with a power-house, oil fuel store and meter house. These buildings are intended to be the nucleus of a large new factory which is to be arranged and equipped on the most modern lines. In company with Mr. Carter, the managing director, and Mr. Iden, the manager, I had an opportunity a few days ago of inspecting these extensions, which will shortly be in full swing. The main shop is laid out in ten 30ft. bays, divided transversely into rough stores, machine section, finished stores and fitting department, with overhead shafting driven by electric motors. Each bay is served by its own overhead cranes, and the lay-out is such that superfluous handling of the products will be avoided. From the rough stores the material will go first into the machine section, then into the inspection department, from which the parts will be given out to the erecting department. Energy for driving the plant is at present being obtained from the electric mains of the Manchester Corporation, but at some not far distant date the firm will no doubt have its own central station, with all the latest developments in connection with power generation by internal combustion engines.

Motor Transport and the Petrol Restrictions.

A committee of the Manchester Chamber of Commerce has been formed to consider the desirability of establishing a special department to centralise the demands for motor traffic and supplies of vehicles for this district, with special reference to return loads. This is being done at the request of the Ministry of Munitions, but the Chamber has had to point out to the Board of Trade that it will be impracticable to proceed with this scheme if sufficient petrol is not to be had. Owing to the railway congestion many firms engaged in urgent Government work have had to resort entirely to the use of motor vehicles for transport in order to expedite their work. The recent drastic curtailment of the supplies of petrol has caused many of these machines to be laid up, this resulting in very considerable loss and inconvenience to traders, as well as delay in essential work. The President of the Board of Trade has promised to give favourable consideration to the request.

BARROW-IN-FURNESS, Thursday.

Hematites.

Whilst there is really nothing new to record this week in the position of affairs in the hematite pig iron trade, the activity all through the district is most noticeable. Makers have not yet been in a position to increase their output by putting new furnaces into operation, but they are not idle in this respect. It is expected that much more iron ore will shortly be available. The local consumption of iron is very big, both at Barrow and at Workington, and considerable tonnages of metal are taken direct from the furnaces to the steel converters. Prices are at the maximum rate, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton net f.o.t., and special brands are at 140s. per ton. There has been nothing done in warrant iron for a long time past.

Iron Ore.

There is rather more activity in the hematite iron ore trade. Some additional men have been started in the mines, and more are expected shortly. The demand for iron ore is very heavy, and local smelters are pressing for fuller deliveries. In addition there is a steady call on outside account, but local users are having the preference.

Steel.

The steel trade is busily employed, both at Barrow and Workington. Makers are giving their attention to work of national importance, and every available mill and department is engaged on a variety of work. Good outputs are being maintained. At Barrow this week the Siemens, rail and merchant mills are on, together with the steel foundry and other branches, but the plate mills are idle. Prices are unchanged, with heavy rails at £10 17s. 6d. to £11 10s., light rails £14 to £14 10s., heavy tram rails £14, ship plates £11 10s., boiler plates £12 10s., and billets £12.

Fuel.

The demand for steam coal is active, and good sorts are at 25s. to 27s. 6d. per ton delivered, and house coal is at 27s. 6d. to 31s. 6d. per ton delivered. For coke there is a keen demand, with East Coast qualities at 33s. to 35s. 6d. per ton delivered, and Lancashire cokes are at 31s. per ton delivered.

SHEFFIELD.

(From our own Correspondent.)

Coke Ovens and By-products.

AN invitation by the directors of Newton, Chambers and Co., Limited, for members of the Midland Section of the Coke Oven Managers' Association to visit the company's Thorncliffe and Rockingham Works here on Saturday, provided an opportunity for interesting statements regarding the future of coke ovens and the supply of electric power. Let me deal with the former matter first, though the second is of even greater importance. Mr. W. Hay, general manager of the company's collieries, contended that, in a large measure, the future prosperity of the country depended upon the efforts of coke oven managements. The party numbered about sixty, of whom Professor Fearnsides, of the Sheffield University, was one, a fact which led Mr. Hay to remark that sometimes scientific men were inclined to be forgetful of the commercial aspect of the industry. On the other hand, directors had to regard the matter purely as a commercial proposition. The coke oven business had in the past been fairly remunerative, though what might be in store for it was not easy to forecast. He only hoped its future was more promising than it appeared to him. They had had in the past a great deal of competition with Germany. Was that to continue? If coke oven enterprises in this country could find a market for their products, and especially if farmers could be persuaded to take more of their commodities, there might be a fair chance of success; but never, Mr. Hay believes, under one-sided free trade conditions. My personal impression is that before the war the practice of some German coke oven and by-product plant makers was to induce British concerns to permit them to put down batteries of coke ovens with the requisite recovery plant, without cost to the firm concerned, on condition that the German installing company was permitted to control all the by-products for a certain period of years. There must have been some of these arrangements in force when the war broke out, and, if so, the sudden cutting off of German control represented a kind of windfall for the British firms interested, especially in view of the urgent call for certain by-products for war material purposes.

Cheap Electric Power Scheme.

The other matter referred to at the gathering related to a proposed big supply of cheap electric power. This is a subject that commands the attention of practically all steel manufacturers and engineers here, for industry seems to be on the verge of great electrical developments. So far as Sheffield itself is concerned that was made very plain by the notes given in THE ENGINEER last week—page 580—of facts contributed to the Incorporated Municipal Electrical Association's meeting, by Mr. S. E. Fedden, the general manager of the Sheffield Electricity Works, regarding the increasing use of electric furnaces. In all directions one sees a growing tendency to adopt the new power. The Sheffield Corporation has a scheme on hand now for enormous new generating power stations to cope with the demand, though to some firms the price per unit has given a considerable amount of thought. That is where the announcement on Saturday comes in. After observing that they had got high temperature distillation to a high state of efficiency, and that they could now devote their leisure to the study of low temperature problems, Mr. Hay added that in order to get the various fractions from low temperature distillation they might have to put down very costly plant. He had been told, he said, within the past few days, that certain people of high standing in the commercial world had been approached in connection with a projected expenditure of £2,000,000 upon a low temperature distillation plant, from which the supply of gas would enable them to produce power at .2 of a penny per unit. "That project," he added, "has been seriously put before certain people not very far distant from Sheffield. Some idea of the gigantic nature of the undertaking will be gathered from the fact that the gas will be conveyed in a pipe 15ft. in diameter, and possible users of this supply of electricity have been told that they can have it at 2d. per unit." Who are the originators of this scheme, and what are the details? It undoubtedly would play an important part in the general scheme of industrial reconstruction after the war.

Prof. Fearnsides' Plan.

The fact that Professor W. G. Fearnsides was one of the party to visit the Thorncliffe and Rockingham works, reminds me of the plan which he propounded more than a year ago. At that time, Professor Fearnsides, who is an authority on the coal measures of the district, was giving close attention to the question of a cheap supply of electricity. That it was needed was, of course, at once admitted. The problem was the supply and cost of the necessary fuel. There was plenty of this in the district, but was it more economical to bring it into

a large generating station in Sheffield or to erect a power station on the coalfield and transmit the current by cable? Professor Fearnsides thought the latter, and at a meeting of the Sheffield Society of Engineers and Metallurgists in the spring of last year, he produced a plan of the South Yorkshire coalfield, showing that it included more than twenty collieries with by-product coke ovens of modern type, and about eighty colliery sites altogether. In about the centre of these he proposed to erect a generating station to supply with electric power, not only Sheffield, but the whole of South Yorkshire. The idea met with a considerable amount of support, and about the same time was brought before a gathering held at the University, under the auspices of the Fuel Economies Committee of the British Association, at which Professor Bone, of the Royal College of Science, South Kensington, gave an address germane to the question of cheap power for Sheffield. In November the subject was again to the front, the suggestion then being the erection of a great generating station near Doncaster, making electricity from the second-grade portion of the Barnsley coal, which is now left unworked in the pits. There is another suggestion. In the surplus gas produced by coke ovens, Professor Fearnsides sees a great unutilised source of fuel which ought to be converted into power. "Wherever by-product coke ovens are worked," he says, "there is an evolution of gas averaging 12,000 cubic feet per ton of coal carbonised. That gas is equal in calorific value to the best Sheffield town gas. In ovens of the regenerative type half of the gas is required to carbonise another ton of coal, and half is surplus. That gas, a little refined, is suitable for most of the purposes to which town gas can be applied. If town gas is suitable for use in gas engines, so is the surplus gas which the coke ovens provide."

Electricity at a Farthing per Unit.

The Professor's plan was to erect a central power station near Doncaster, and to convey to it, through pipes laid from the ovens, this surplus gas, using it in the production of electric power. He estimates that there are more than 20,000 kilowatts immediately available from that source, and, although that would in no sense meet the present demands of Sheffield, it would prove a valuable supplemental supply, and in co-operation with the Corporation's stations and that of the Yorkshire Power Company, might meet immediate needs. The growth of the use of electricity is, however, so enormous, that he anticipates the demand in Sheffield alone may rise to 250,000 kilowatts within the next ten years. There is in this district, and easily accessible, he contends, sufficient unwon second-class coal to generate electricity in large stations to the extent of hundreds of thousands of kilowatts. It will be seen, therefore, from these brief details, that the scheme is full of possibilities industrially, and is regarded with much favour by circles that count. I remember some few months ago, Mr. G. Blake Walker, whose opinion as a mining authority stands high in this part of the country, expressed the view that a plan of the kind described, in addition to supplying electricity to Sheffield, Rotherham, and surrounding towns, would find plenty of scope for development. There is a big field for the substitution of electric power for steam power at the collieries themselves. It was possible, Mr. Walker thought, to reduce power costs at the colliery by one-half, if, instead of each colliery generating its own power it was supplied with cheap electricity from a large centrally-situated power station. The same argument, of course, applies to some of the Sheffield works which still make their own electricity, though many that did so have abandoned it in favour of the Corporation supply, which has the advantage of duplicate engines in case of breakdown, while in at least one instance of which I know the firm make its own, but has connections in readiness to transfer the load to the municipal cables in case of an accident to its own plant. When the Trent Navigation Company's meeting was held back in April, I remember the chairman, Mr. Ernest Jardine, mentioning that a company that had taken in hand the industrial development of a large estate in Nottinghamshire, proposed to erect, amongst other things, a low temperature coal-carbonisation and power plant, by means of which it was estimated electric current would be sold at a halfpenny a unit, but under the present scheme power will apparently be available at only half that price.

Degree Day.

Degree Day at the Sheffield University on Saturday was notable for the announcement by the Vice-Chancellor, that subject to formal election by the Court, the Marquess of Crewe will be the Chancellor of the University, in succession to the late Duke of Norfolk. Lord Crewe is not without sound claims to the position. He comes of an old Yorkshire family, and as chairman of the Governing Body of the Imperial College of Science and Technology has gained valuable experience. Moreover, he did good service for Sheffield when, some years ago, the London University, with which his Lordship was associated, had under consideration the establishment of a steel department. A deputation was sent from Sheffield to ask Lord Crewe to agree that Sheffield should be the centre of the scientific study of steel. To these representations he listened, recognised that the University here was doing work of national importance, and expressed the view that it was unnecessary for any other centre to be set up to duplicate its work. Thereafter it was arranged that students in London who desired to specialise in steel should come to Sheffield University to take that part of their course of study.

Round the Works.

Steel-furnacemen's thirsts are prodigious, and their particular weakness is beer. It will be understood, therefore, that the recent shortage in the supplies of the beverage—a "famine" they call it—has perturbed them considerably. The number of quarts which one furnace hand will consume per diem is almost unbelievable. Most of the firms provide the men with ample supplies of oatmeal water, for some kind of drink is absolutely essential, but their enthusiasm for the stronger kind leads them to accuse oatmeal water of "irritating the skin." One firm, just over the Sheffield boundary, has hit upon a plan for overcoming the shortage difficulty. Adjacent to its large steelworks is an hotel, control of which has been obtained for an experiment. The beer supplies are to be reserved for the firm's employees, with very judicious restrictions upon the consumption per man, and total suspension of supplies over the week-end. If the experiment proves successful it will be, apparently, continued for the duration of the war, or at any rate during the "beer famine." Regarding general trade, there is still a great amount of activity in exports of steel and its products, and what characterises shipments just now is the bulk of the consignments. Canada and the Far East are taking large quantities of steel goods. At home, War-office and Admiralty contracts show no diminution, particularly for edge tools, shovels, picks, saws, &c., but some manufacturers complain that Government officials are paring down the margin of profit too vigilantly. Firms, of course, have their statements of costs officially examined, and that, presumably, is the outcome. There are important works extensions going on in the Rotherham side of the district, including the installation of new blast and steel furnaces, and the Rotherham Corporation has very large plans for increasing the supply of electricity for power purposes. There are other developments in the district which, however, do not seem ripe yet for detailed mention.

The Redbourn Hill Developments.

In my reference last week to the steel furnace developments of the Redbourn Hill Iron and Coal Company, at Frodingham, I mentioned that the estimated output of the four new furnaces was about 2000 tons of basic steel per week. This was understating the fact. The output, I am told, is estimated at from 3000 to 4000 tons weekly.

Iron, Steel, and Coal.

There appears to be very little change to note in the market here for hematite, and common irons, and basic and acid steel, though in all cases freer supplies would be welcomed. Values are very firm on maximum rates, and iron and steel scrap and turnings are in strong request. Steam coals maintain activity, outputs going away freely, chiefly on inland account for munition works. Exports to neutrals are attenuated, but Allies are taking fairly good supplies. Slacks are in great demand, and some works cannot get all they require. The same remark applies to nuts. The house coal position shows little or no change. Best South Yorkshire steam hards are quoted 17s. 9d. to 18s. 3d.; best Derbyshire, 17s. to 17s. 3d.; seconds, 16s. 6d. to 16s. 9d.; cobbles and nuts, 16s. 6d. to 17s. 6d. In house coals, branch is quoted 21s. 6d. to 22s. 6d., and best Silkstone 18s. 6d. to 19s. 6d. per ton at pit.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

VERY satisfactory accounts are given regarding the position of the Cleveland pig iron trade. The furnaces are being kept going at full pressure, and an enormous output is maintained. The market is exceedingly firm. The July allocations to the home foundries have been issued very promptly by the Control Committee, which now has this business in hand. But, generally speaking, the applications this month are fewer in number, and for lesser quantities; while in a number of cases there is no particular hurry as regards deliveries. This is accounted for by the holiday period in Scotland, but both there and in the North of England there is a diminution of pressure at the foundries, except where contracts for shipyard requirements are proceeding. The forward position is quite neglected, buyers having no present inducement to book ahead. A large business is being done in shipping iron, chiefly for France. For home consumption the price for No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge remains firm at 92s. 6d., while No. 1 is at a premium of 4s. The export quotations are:—No. 2, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d. The stock of pig iron in the Public Store at the end of June amounted to only 1358 tons, all No. 3 quality, a reduction on the month of 515 tons.

Hematite Pig Iron.

Considerable activity still characterises the East Coast hematite pig iron trade. There is a continuously heavy demand, and the output is being carefully allocated according to the respective urgency of requirements. In the home trade consumers are receiving their quantities with fair regularity. There are improving shipments to the Allies. New business is only entertained subject to such adjustments of price as may have been decided upon when the licences are obtained and tonnage available. In view of the time which necessarily elapses before the definite fixing up of contracts, quotations are purely nominal. These are, for France 137s. 6d., and for Italy 142s. 6d. The home maximum price is firm at 122s. 6d.

Iron and Steel Exports.

The exports of pig iron from the Cleveland district during the month of June amounted to 60,638 tons, as compared with 59,915 tons in May, an increase of 723 tons. This is the largest total since last August, when 63,635 tons were shipped. The shipments in April amounted to only 37,297 tons. The shipments of manufactured iron and steel amounted to 20,752 tons—iron 3798 tons, steel 16,954 tons—as against 33,315 tons in May, a decrease of 12,563 tons. The shipments in April, however, only amounted to 20,232 tons. The aggregate shipments of pig iron and finished iron and steel amounted to 81,390 tons, as against 93,280 tons in May, a decrease of 11,840 tons.

Iron-making Materials.

Business in foreign ore is more active, and tonnage is more plentiful. The coke market is rather easier after the recent abnormal demand. Prices are firm and unchanged at the maximum rates, good medium furnace kinds realising round about 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

The demand for all descriptions of manufactured iron and steel for war purposes and for the shipyards is more intense than ever. Ordinary commercial business is quite out of the question, while exports to the Allies are strictly limited and controlled. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ¾in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 5/16in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

No new developments have occurred in the scrap trade. Each week witnesses a growing difficulty in getting supplies, the demand for almost every line being larger than can be satisfied. Some merchants are complaining that official tendency is to encourage direct transactions between producers and consumers, thus putting to one side firms which have for many years engaged in the business. The question of making representations to the Ministry of Munitions is under discussion. There is a very large inquiry for heavy steel melting scrap, but sellers are reserved, as they are not satisfied that the supply will in future be equal to the demand. The supply of steel turnings and borings has diminished considerably of late, and consumers are experiencing some difficulty in fulfilling their requirements. Wrought iron scrap, too, is not being offered to any extent, and dealers have their hands full in searching for enough to cover old contracts. Current prices are: Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, ¾in. thick and over, £6 5s.; heavy wrought iron scrap, ¼in. thick and over, £5 5s.

Coal Trade Control.

The new directions issued this week by the Controller of Coal Mines have absorbed the whole attention of those engaged in the coal trade, and animated discussions thereon are the chief items of interest. The central idea of the innovation is to prevent fluctuations in colliery prices arising from the present abnormal market conditions, and to preserve regularity in the distribution and export of coal in the different producing and exporting centres. Consequently the directions mainly affect prices. Pit prices for home consumption are to remain at the maxima prescribed and in force under the Coal Price (Limitations) Act. It is stipulated that collieries shall specify whether coal sales are for home consumption, for shipment to France or Italy, or for shipment to other destinations. The present system of licences for shipment will be retained, and existing contracts within specified limitations are not to be interfered with. The prices have been classified and graded for each district, and are understood to be the colliery prices f.o.b., merchants being allowed a remuneration of not less than 5 per cent. on the f.o.b. price, to include foreign agents' commission and other expenses. In the main the new prices are based on the maximum selling prices in force for the Allied countries, but many of the inferior brands have been advanced somewhat so as to eliminate the very wide difference between these and first-class coals, which has lately prevailed. It is impossible to judge yet how far the scheme will succeed in steadying prices, though it is hoped to accomplish that end. It admits of no doubt, however, that the Government intends to increase its hold on the coal trade.

The New Prices.

The new schedule prices for Northumberland are as follows:—Best steams of the Davison, Cowper, Bothal, and Bentinck classes are 30s., with unscreened at 25s., nuts at 26s., and smalls at 20s.; secondary best steams of the Bebside, Hastings, and Hartleys are 25s. 6d. to 27s.; unscreened, 23s. 6d. to 24s.; nuts, 26s.; and smalls at 18s. 6d. The Durham classes are similarly priced with Northumberlands. Best steams of the Hetton, Lambton, and Ryhope classes are 30s., with secondary classes, 28s. 6d.; nuts and peas, 24s. 6d. to 25s.; smithies, 25s.; manufacturing smalls, 20s. Coking coals of the Bearpark, Burnhope, Marley Hill classes, 25s.; best house coals of the Wallsend, Dean and Chapter, Hetton, &c., 30s.; and for seconds of the East Hetton, Hawthorn and Mainforth classes, 28s. 6d. Bunkers of the Marley Hill, Morrisons, Towneley classes, 25s.; with Brancepeth, Burnhope, Consett, Framwellgate, &c., class, 26s. 6d.; with Baldon, New Felton, Holmside, at 25s.; and Brandon, Helling, Pelaw Main, West Leversons, &c., at 23s. 6d. The position is a little involved, and many points need elucidation before the market can settle down to the new conditions. There is some doubt as to the incidence and effect of brokerage commissions and difficulties are anticipated. Meanwhile the new prices are the basis of any business that is effected, but in view of the time necessary to communicate with customers abroad, and also to gain a full understanding of the new situation here, there is very little business that can be transacted. The tone of the market, under the circumstances, is very well sustained, and producers have no anxiety as to placing their output. Official requisitioning and shipments on contract are on a very extensive scale, and only leave small lots to be cleared on the open market.

SCOTLAND.

(From our own Correspondent.)

Unskilled Workmen's Wages.

A CASE of considerable interest in connection with the payment of unskilled workmen has recently been under review by the Glasgow Munitions Tribunal. The point at issue was whether an unskilled worker employed in a Clyde shipyard, having served the probationary period, and being engaged on work customarily undertaken by a turner, was entitled to demand the district rate of wages payable to a turner. The claim was refused by the Glasgow Munitions Tribunal, and was appealed to the Munitions' Appeal Judge, who has upheld the decision of the Tribunal. In his—Lord Hunter's—opinion, the question of the appellant's efficiency was entirely a question for the management.

The Pig Iron Trade.

Scotch pig iron makers continue to do a very large turnover. The pressure on the works is very severe, and a high average output is maintained. Hematite is particularly active, but No. 1 foundry quality is not far behind, while all brands are becoming more scarce. Private home consumption is confined within small limits, and the export department is only doing a minimum amount of business, almost entirely for the Allies. Prices are all firm, with practically no change, though it is said that some makers are asking a shilling or two extra for any available material. Stocks are very far reduced, and the daily output is taxed to the utmost.

Quotations.

Monkland and Carnbroe, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

Strong conditions still characterise the various departments of the finished steel and iron trades. The bulk of the output is immediately absorbed on war account, and energies are almost entirely turned in that direction. The pressure at the steel works for shell bars and material for standard ships is as heavy as ever, and mills are fully occupied. The heavier gauges of black sheets are in constant request. Galvanised flat and corrugated sheets are too high in price for ordinary mercantile use. In the malleable ironworks, the majority of the mills are still busy with war work. The huge demand for steel has caused a large decrease in the production of iron, and outputs of the latter are now fully accounted for by war necessities. Private consumers are able now and then to pick up some serviceable shell-discard material, but otherwise this class of business is reduced to a minimum. Quotations, however, remain on a firm basis. Activities in the shipbuilding and engineering trades are undiminished. Excellent progress is reported from the shipyards, while the output of all classes of machinery, especially machine tools, is enormous.

Coal.

No move in the direction of an improvement can be reported in the Scotch coal trade, and the general condition of the markets is disappointing. Orders are lighter and prices tending lower, while costs of production remain on a high level. Collieries in the West of Scotland, where the industrial demand is comparatively full, are not badly off, but in the East of Scotland great difficulty is experienced in disposing of outputs, and employment is very irregular. Gas coal contracts are usually settled about this time, and Glasgow Corporation has just purchased about 180,000 tons of coal on slightly more advantageous terms than last year. This, however, is not calculated to reduce the charge to the gas consumer, owing to increased costs of production in other directions. Values show little alteration from last week, but the tendency is in a downward direction. Ell coals are quoted, f.o.b. at Glasgow, 18s. 6d. to 20s.; splint, 21s. to 26s.; navigations, 26s.; steams, 17s. to 19s. 6d.; treble nuts, 23s. 6d.; doubles, 22s.; singles, 20s.; best screened navigations, f.o.b. at Methil or Burntisland, 27s.; first-class steams, 23s.; third-class steams, 19s.; best steams, f.o.b. at Leith, 20s.; secondary qualities, 18s. per ton. The aggregate shipments from Scottish ports during the past week amounted to 151,343 tons, compared with 164,140 in the preceding week, and 220,045 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

A Conciliation Board that Conciliates.

HAPPILY the labour trouble in the Siemens steel and tin-plate works of South Wales is ended, and there was a full resumption of operations last Monday, upon acceptance by the men of a war bonus of 15 per cent. as offered by the employers. The strike did not have the sanction of the trade union officials, but was summarily launched by the men through irritation engendered by their exclusion from the latest war bonus granted by the South Wales Tin-plate Conciliation Board, on the ground that they had been already dealt with under the award to members of the Amalgamated Society of Engineers.

Eventful Week in the Coal Trade.

This has been an eventful week in the South Wales coal trade. At last the Coal Controller's schedule of fixed prices has been issued, and the entire market conditions have undergone fundamental changes. It will take time for the commercial side of the coal industry to adjust itself to the new order, and no safe prediction of the course of business can be made until the classification of the various collieries is completed. The Coal Controller's schedule establishes not only fixed prices for coals exported to France and Italy, including the protectorates and possessions of both, but imposes these fixed prices as the minimum figures for coals intended for other destinations. The broad effects of this comprehensive change are obvious: —(1) The element of fluctuation in market conditions is eliminated from the prices charged to our Allies; (2) the removal of the anomaly whereby neutral customers were in a position to obtain supplies at prices which fell below the rates charged to Allied consumers; (3) a careful graduation of fixed prices with some approximation to trading conditions. Throughout the schedule the new fixed prices are higher than the approximate quotations current last week, as the following table will illustrate :—

	Schedule prices. s.	d.	Latest quotations. s.	d.
Steam coals :—				
Best Admiralty, large	33	0	29	0
Best seconds	31	6	28	6
Seconds	30	9	27	0
Ordinaries	30	0	26	6
Best drys	30	0	27	6
Ordinary drys	28	6	26	6
Best bunkers, smalls	23	0	16	6
Best ordinary	21	6	15	6
Cargo smalls	20	0	14	6
Best Eastern Valleys	29	0	27	6
Best washed nuts	30	0	29	6
Seconds	28	6	28	0
Bituminous coals :—				
Best house coal	33	0	27	6
No. 3 Rhondda, large	30	9	27	0
No. 2 Rhondda, large	27	0	24	0
Do., throughs	25	0	18	6

Critics have not perhaps had sufficient time yet to focus objections on points of detail in the price graduation. For the moment the only serious criticism is that the graded prices—which are operative as from June 28th—should not have been issued pending the completion of the classification of collieries, the coals of which are to be sold at the new fixed prices. This classification is now in course of preparation by a committee of the South Wales Coalowners' Association, and will be completed without delay. Pending the issue of the final classification all the colliery companies are to adopt the classification which they have submitted to the committee, and the prices charged for coal will be subject to revision hereafter in order to conform with the final classification of the various collieries concerned. In the circumstances this is obviously the best arrangement possible, but it falls far below the efficiency that would have been guaranteed if the new schedule of fixed prices, and the classification of collieries, had been issued simultaneously.

Colliery Compensation Scheme.

There is a confident feeling in South Wales coal circles, that the issue by the Coal Controller of the financial compensation scheme for collieries in connection with the Government control plan is now only a few days distant. Apparently the agreement, as drafted a week ago, was accepted by all the colliery owners in the country with the exception of those of South Wales, who raised a few important points for further consideration by the Controller. How far the objections raised have been met we shall not know until the issue of the official statement. The public is indebted to Lord Aberconway, chairman of the Tredegar Iron and Coal Company, Limited, for revealing the main principles of the compensation scheme. In his speech at the annual meeting of his company held during the week end, he announced that it was proposed to allocate 15 per cent. of colliery companies' excess profits to a fund intended to maintain a standard dividend in the case of weak collieries, so far as that might be necessary, and any surplus not absorbed in that way would, he supposed, go into the Exchequer. In the case of collieries therefore 80 per cent. of the excess profits fell into the hands of the State under the Finance Act, and of the remaining 20 per cent. colliery owners would have control of only 5, as 15 per cent. was earmarked for dividend maintenance at the less remunerative pits. Lord Aberconway complained that the colliery shareholder fared infinitely worse than the colliery worker. Their men were, he said, now getting a percentage of 55 on the new wage standard, which was equal to 130 on the old standard, this rise being, he presumed, guaranteed to make good the extra cost of living, but the shareholders received no increase and no war bonus of any kind.

South Wales Coal for Ireland.

Important arrangements have been completed whereby certain coals hitherto supplied by the Midlands to Ireland will be diverted to London, and the deficiency thus caused in the supplies to Ireland will be made good by the substitution of South Wales house coal. These arrangements will materially economise railway transport, as the South Wales coal can be shipped with a minimum of antecedent railway traffic, whilst they will, in addition, offer further guarantees for an adequate London supply.

The Personal Factor in Labour Unrest.

Major Harries, of Swansea, one of the best known commercial leaders in South Wales, made a striking statement last Monday at the Swansea sitting of the Labour Unrest Commission for Wales, illustrating the efficacy of personal contact in the maintenance of good relations between employers and employed. Dealing with the port of Swansea, Major Harries said the record of labour troubles, until a comparatively recent date, was lengthy in number and serious in trade handicap. But a new departure in the relations of the Harbour Trust with workmen's leaders had already effected a wonderful transformation. This new departure consisted in the appointment by the Harbour Trust of one of its members to attend meetings of the workmen arranged by labour leaders for the full discussion of the labour position. The effect had been remarkable, this method of direct personal interview having resulted in the establishment of the best relations.

Wages Questions.

The audit for the three months ended May 31st, conducted under the auspices of the South Wales and Monmouthshire Iron and Steel Workers' Sliding Scale, yield an advance of two per cent. for men employed at associated works as from July 1st. The percentage above the standard wage is now no less than 89½. The Barry riggers and boatmen have communicated with the employers, accepting the latter's wage offer in complete settlement of the demands. This settlement places the Barry men on terms of equality with the Cardiff riggers and boatmen, who a week ago, under the award of the Committee on Production, received an increase of 12½ per cent., making a total wage increase since the war of 37½ per cent.

Current Business Position.

The far-reaching developments of the week have resulted in a suspension on a large scale of the ordinary business on the Cardiff coal market, and no material alteration is expected pending completion of the classification of collieries to correspond with the new fixed schedule of prices. For the moment, colliery salesmen are quoting the new fixed prices without qualification, with the possible exception of bunkers, as regards which some of the new directions are more or less obscure. Business is, therefore, on a very restricted basis, and the hindering factors are accentuated by the few arrivals of ships over the week-end, the number being considerably below the average. There is a plentiful supply of coals, especially bunkers, but transactions in only a few parcels are reported. The committee on the classification of collieries is hard at work day by day, and the issue of the list may be expected shortly. The following quotations are according to the new schedule, pitwood and patent fuel excepted :—Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; patent fuel, 30s.; pitwood, ex ship, 70s. to 72s.

Newport.

At Newport the position is in most respects a duplication of that existing at Cardiff. As at the other ports, the schedule prices are being quoted as a matter of form. The following is the schedule list, with the exception of pitwood and patent fuel :—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s. Bituminous coals: Best house, 33s.; seconds, 30s.; patent fuel, 30s.; pitwood, ex ship, 70s. to 72s.

Swansea.

The market at Swansea also presents unusual difficulties, and the business transacted is on very restricted lines. There is a consensus of opinion that the higher fixed prices for export will operate detrimentally on inland orders, particularly so in the case of anthracite machine-made nuts. There is a fair market for bituminous coals, but steam smalls are in poor demand. The following is the schedule list, with the exception of pitwood and patent fuel :—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 42s. 6d.; French nuts, 42s. 6d.; stove nuts, 42s. 6d.; beans, 35s.; machine-made large peas, 20s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, 25s.; smalls, 19s. Bituminous coal: Throughs, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates, &c.

The various tin-plate works are again in full swing, and there is a confident hope that the settlement of the craftsmen's strike will prove lasting. In wages alone last week's strike is estimated to have cost £20,000. The tin-plate market continues very firm, practically all manufacturers being well booked with orders for some time to come. There are further heavy requisitions of stock plates on behalf of the French Government, and stocks at works and dock warehouses are being rapidly depleted. Any available stock lots—which are few in number—are realising high prices, especially plates, which may be dealt in without a certificate. Quotations :—Block tin, £242 15s. per ton cash; £237 10s. per ton three months; copper, £130 per ton cash; £129 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

THE Buffalo, Rochester and Pittsburg breaks up all its large castings that are put upon the scrap heap. Whilst scrap will fetch 14 dols. per ton these large castings only fetch 8 dols. About 26 tons of large castings can be broken up in a day, and the cost of labour is about 12 dols. Deducting this there is a profit of 144 dols. for 26 tons of large castings should they be first broken up.

IT is possible that one desirable result of the entrance of the United States into the war may be a considerable reduction in the number of trespassing accidents on the railway there. Public notice has been given that in addition to the ever-present danger of being killed the man who now trespasses on railway property subjects himself to the peril of being shot, should he fail to heed the challenge of the military guard. Charged with the duty of protecting railway structures, whose destruction would interfere seriously with transportation, the guard cannot afford to take any chances.

THE general superintendents of the Pennsylvania Railway have been instructed by the general manager, to investigate and report, as early as possible, on the capacities in which girls and women can be efficiently employed on all parts of the system; what numbers can be so utilised, and to what extent they can perform the work now being done by men. One object aimed at by this action is to prepare for the probability that selective conscription will ultimately result in a considerable depletion of the forces of male employees not actually engaged in the physical operation of the railroad.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

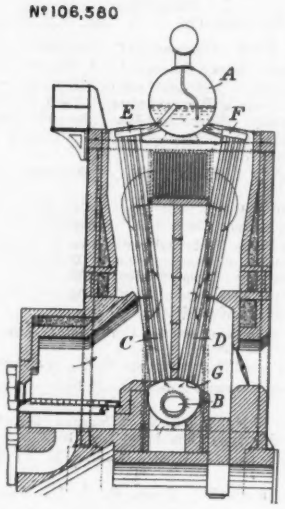
The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

106,580 (14,067 of 1916). October 4th, 1916.—WATER-TUBE BOILERS, Alexandre Pannetier, Reval, Scheliesnaja-street, No. 17, Log. 4, Russia, Government of Estland, Russia.

This invention relates to a water-tube steam boiler having an upper or steam drum A, and a lower water drum B, supported by brickwork, and having two sets of water tubes C D connecting the lower drum with two sets of intermediate chambers E F at the sides of the upper drum. The lower water drum is formed with an upper plate G curved at a radius exceeding that of the

Nº106,580



lower part of the drum. The intermediate chambers E F are arranged with their lower wall running substantially parallel with the corresponding part of the upper plate G, so that all tubes of a set, or of both sets, may have the same length. The tubes connecting the intermediate chambers to the upper drum are so incorporated in relation to the brickwork that the tubes connecting the lower drum with the intermediate chambers are enabled to expand longitudinally in accordance with variations of temperature.—*May* 31*st*, 1917.

106,582 (14,995 of 1916). October 21st, 1916.—SECTIONAL STEAM BOILERS, James Howden and Co., Limited, 195, Scotland-street, Glasgow, and another.

This invention is concerned with the disposition of the superheaters in multi-sectional steam boilers of the kind described in Specifications Nos. 26,330 of 1908, 27,449 of 1910, and 5383 of 1912. Figs. 1 and 2 show the arrangement, A, B and C, being the lower and upper water and steam drums and steam collecting drum respectively. Led from the upper part of the steam collecting drum C are pipes D, coupled to headers E, receiving the upper ends of U-shaped superheating tubes F, of which the

Nº106,582

Fig. 1.

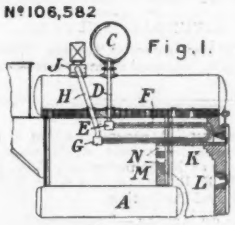
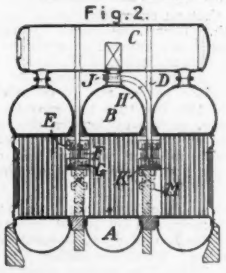


Fig. 2.



opposite ends are connected to headers G, from which are led pipes H to valve casings J fitted with a steam stop valve. As shown, the superheater tubes F are partly contained in flues between the stacks of upright tubes, and partly in spaces between the combustion chambers, being shielded from the hottest products of combustion by fire-brick shelves K sustained by partition walls L. Obstructing the passage of hot combustion products from the combustion chambers to the flues are partitions M of chequer brick-work, openings N in which may be closed at will by the insertion of loose bricks.—*May* 31*st*, 1917.

INTERNAL COMBUSTION ENGINES

106,561 (11,120 of 1916). August 7th, 1916.—COMPRESSION RELEASE MECHANISM, Arthur Sydney Baylis, 2, Lowther-street, Coventry.

This mechanism consists of a spring closed compression relief valve having opening means such as a Bowden wire operatively connecting the valve to a point adjacent to the controls of the engine, and another spring-controlled valve on the exhaust side of the relief valve, which can be forced on to its seat by the firing stroke of the engine. The arrangement is shown in Figs. 1 and 2. A pipe A is screwed to the cylinder B, and a tapered valve C is held in the closed position in the valve casing D by a spring E. The valve is recessed at F so as to afford release of compression when opened by pulling a Bowden wire G. The wire is provided with a ball end H which engages with a shoulder I at the end of the valve. The gases passing the valve open a non-return valve J against the pressure of a spring, and pass down the pipe L to the exhaust pipe. The back of the valve J can be forced automatically to the seating M, on the firing stroke,

Nº106,561

Fig. 1.

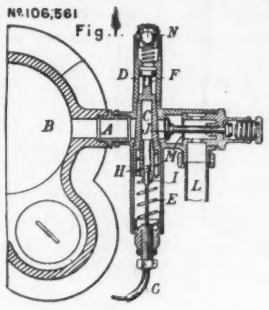
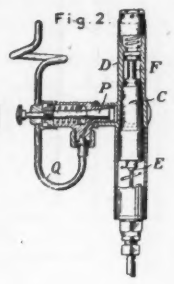


Fig. 2.

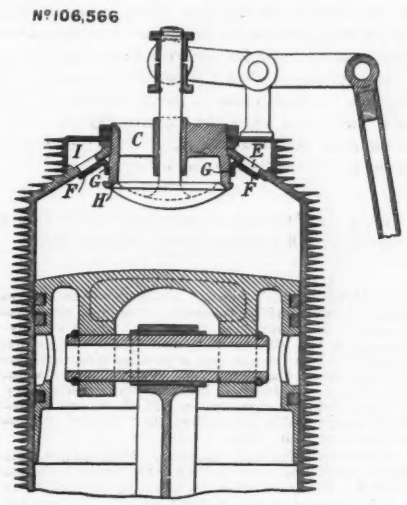


whereby communication with the exhaust is closed even though the plunger valve be open. A spring-closed non-return valve N admits air to the engine for scavenging when the plunger valve C is open. A priming device comprising a spring-controlled conical injection valve P is connected to the main valve casing D, and when the valve P is pushed off its seating a suitable quantity of fuel is drawn into the engine from the supply pipe Q.—*May* 31*st*, 1917.

106,566 (11,749 of 1916). June 22nd, 1916.—OVERHEAD VALVE MECHANISM, Basil Haward Hardy, 3, Burton-grove, Dewsbury-road, Leeds, and another.

This invention consists in arranging the inlet port or ports in the coned head of the cylinder, and controlling them by a tapered or coned valve, which may be actuated automatically by suction or mechanically, as desired. C are the exhaust ports, and E the inlet ports adjacent to the exhaust ports. The inlet ports are controlled by a coned valve F, the seating face of which is inclined to suit the inclination of the cylinder head. The valve

Nº106,566



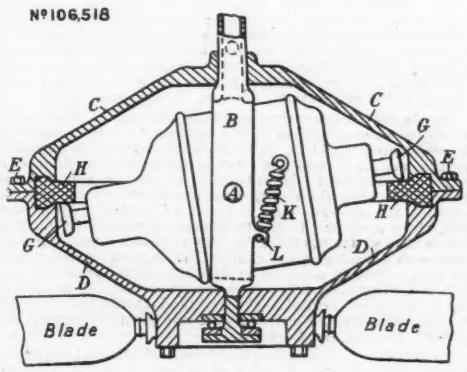
F is preferably made of some light metal, and is provided with a cylindrical sleeve-like portion G adapted to surround and engage the sleeve H forming the seat for the exhaust port, so that the inlet valve may move within limits upon the exhaust valve seating for the purpose of opening and closing the admission ports E. The fluid chamber I, from which the power medium is admitted to the cylinder through the inlet port or ports, is thus arranged upon the coned cylinder head, so that the external appearance of the engine is improved, and its resistance to wind pressure materially diminished.—*May* 31*st*, 1917.

DYNAMOS AND MOTORS.

106,518 (7214 of 1916). May 20th, 1916.—REDUCTION GEARING FOR ELECTRIC FANS, Carlyle Adams Atherton, Belton, West-road, Bowdon, Cheshire.

This is an arrangement of gearing specially designed for electric fans, and the illustration shows the invention applied to a

Nº106,518



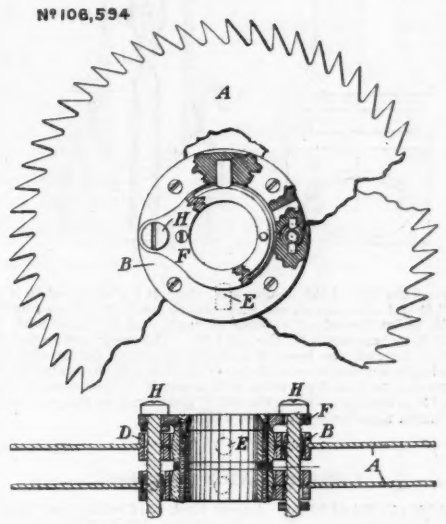
ceiling fan. The motor is supported by pivots A in a ring B, by which the entire apparatus is hung from the ceiling. Mounted to rotate on the supporting ring is a yoke formed of two parts, an upper part C and a lower part D, which are united by bolts E, the plane dividing the two parts passing through the axis of the pivots. The annular gear, which is preferably made of rubber, leather or raw hide, is clamped between the upper and lower parts of the yoke, and each end of the motor spindle F is provided with a brass or steel pulley G. The axis of the motor is tilted out of the plane of the gear ring H, so that one of the pulleys engages with the upper surface of the ring, and the other with the lower surface. The weight of the motor is unsymmetrically adjusted on its pivots so as to obtain a suitable driving pressure between the pulleys and the surfaces of the gear ring; in the drawing this pressure is assisted by a spring K, one end of which is connected to the motor, and the other end of which is hooked over a projection L on the ring B.—*May* 21*st*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

106,594 (1663 of 1917). February 1st, 1917.—CIRCULAR SAWS, Emile Auguste Mouche, 61, Rue de Bonnel, Lyons, France.

According to this invention circular saws are mounted in adjacent parallel positions upon crowns pivoted to a fitting carried by the saw spindle, and the crowns are provided with

Nº106,594



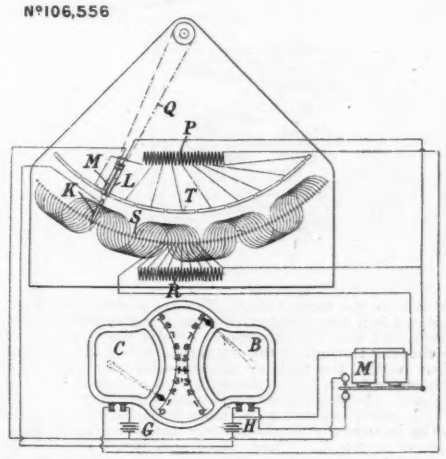
pivoting sleeves through which regulating screws are inserted, so that the sleeves may be moved to adjust the respective crowns and saws carried by them into the particular angle required. The arrangement is clearly shown in the sectional views, A being the saws, B the crowns, D the rings mounted on pivots E. F is an assembling disc, and H the regulating screws.—*May* 31*st*, 1917.

TRANSMISSION OF POWER.

106,556 (9866 of 1916). July 13th, 1916.—ELECTRIC CONTROLLER, Thomas McLeod, Middleton Brass Foundry, Middleton, Hartlepool, Durham.

This specification describes a method of controlling instruments in two circuits by the movement of a single arm having wipers which sweep across two ranges of contacts. A relay is used in such a manner that when the arm is in certain positions the relay is energised to effect the de-energisation of the instruments in the first circuit and to effect an increase in the energisation of the instruments in the second circuit. The arrangement is shown in the illustration, the two ranges of contacts being shown at S, T, while R, P are resistances by which the value of the current flowing from the batteries H and G

Nº106,556

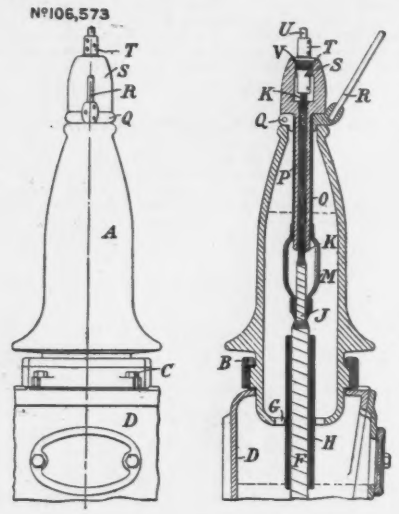


through the indicating instruments B and C can be varied by the moving arm Q, carrying the wipers K, L, M. The control is effected by connecting a particular pair of contacts in the range of contacts controlling the first circuit with the core coil of the relay M, so that when a wiper reaches such contact the relay is energised, its armature is moved, and current passes to a contact and wiper in the second range of contacts. The flow of current to the first circuit is cut off when the relay is energised by passing such current through separate contacts controlled by the armature of the relay, such contacts only touching when the relay is de-energised.—*May* 31*st*, 1917.

106,573 (13,150 of 1916).—ELECTRIC CABLE TERMINALS, W. T. Henley's Telegraph Works Company, Limited, 13 and 14, Blomfield-street, London-wall, London, E.C., and another.

This invention is for an insulator which is designed for terminating a two-core concentric cable. The insulator A is clamped by a ring B and bolts C to the top of a terminal box D. The cable F passes through an aperture G in the base of the insulator A and is protected by a sheath H of insulating medium. The outer conductor J is bared and cut back to some distance from the end of the cable F, and the inner conductor K is bared for a smaller distance. The outer conductor J is

sweated on to a fitting M which extends towards the end of the cable F beyond the point to which the inner conductor K is bared. The fitting is of open structure or provided with lateral apertures to permit the filling compound to gain ready access to the conductor K. The fitting M is united with a copper tube O through which the inner conductor K passes in a tube of insulating material P. The copper tube O extends slightly

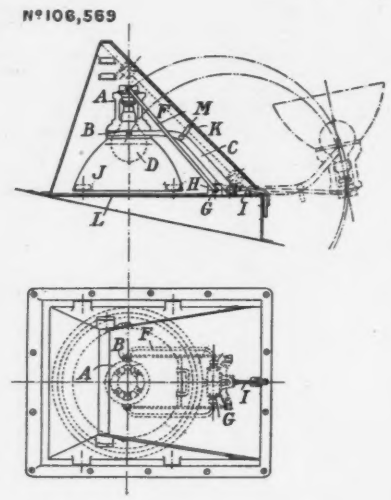


beyond the end of the insulator A, where it has clamped to it a part Q and also has an external branch conductor R connected to it, whilst the tube P extends through, and is formed with a head S to bear against, the part Q. The inner conductor K passes through the head S and has mounted on its end an externally screw-threaded sleeve T with a branch conductor U connected to it and provided with a nut V to bear against the head S in order that when the nut V is screwed up the parts will be drawn together.—*May 31st*, 1917.

LIGHTING AND HEATING.

106,569 (11,961 of 1916). August 23rd, 1916.—ELECTRIC LAMP MOUNTINGS, Sir W. G. Armstrong, Whitworth and Co., Limited, and another, Elswick Works, Newcastle-upon-Tyne.

The lamp holder A, which is made in two parts bolted together to facilitate wiring, has trunnions B upon its lower end, the trunnions being supported by a pair of pivoted levers C, whilst the upper end to which the lamp D is secured has friction bearings E supported by a pair of hollow levers F pivoted to friction bearings G. The bearings of the levers are carried by a box H containing cable connectors. From the cable connectors in the box insulated wires I are led through either or both of the hollow levers to the top of the holder. A reflector J is

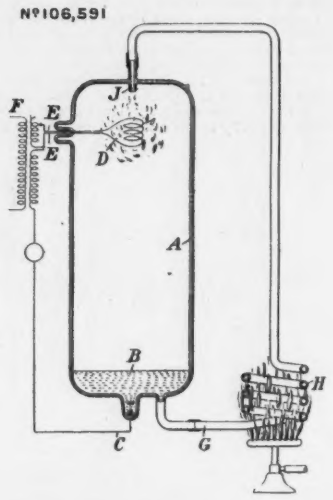


secured to the lamp holder. The lamp with its fittings is mounted in a compartment built into a wall or roof which is so constructed that the atmosphere outside the building is free to circulate throughout the compartment, but that the atmosphere within the building cannot enter the compartment. The compartment is provided with a door K, and the side L is of glass. The cleaning or examination of the lamp or its fittings may be easily effected, as is shown in dotted lines, by pulling the lamp out of the compartment by means of a handle M on the pair of levers C. These lamp mountings are especially adapted for use in lighting buildings from the outside.—*May 31st*, 1917.

MISCELLANEOUS.

106,591 (1581 of 1917). January 31st, 1917.—VAPOUR ELECTRIC CONVERTER, British Westinghouse and Electric Manufacturing Company, Limited, 2, Norfolk-street, London, W.C.

This is a vacuum type of converter in which the cathode is heated to incandescence and is also subjected to a blast of superheated vapour during operation. The anode is of the vaporisable reconstructing kind, such as mercury. A is the converter, B the anode, C the leading-in wire, D the cathode in the form of a filament of tungsten or molybdenum. The leading-in wires E are connected to a source of heating current F, and both the anode and cathode are connected to the terminals of a source of alternating current. The container is filled with one of the rare gases of the atmosphere, such as argon, under pressure and a blast of superheated vapour is maintained upon the cathode by taking material from the anode through a tube G, passing it through a boiler H and spraying it through the nozzle J upon the cathode. It is claimed that in the operation of the device substantially no positive electrons are produced by the collisions of the negative electrons emitted at the cathode with gas molecules, but the electrons proceed to the anode and produce an



exceedingly stable and satisfactory arc suitable for current rectification or for other purposes. The effectiveness of operation of the device is greatly enhanced by the presence of the blast established from the nozzle J.—*May 31st*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of six of the patents given below £26 and on each of the remainder £18 have been paid in renewal fees.

No. 15,891/10.—Vehicle wheels. Building wheels; a method of building tires comprising transverse or oblique radial leather strips consists in compressing the strips, placed one by one or in groups in the dovetailed groove of the rim, between a metal piece fixed to the rim and a pressing-piece actuated by suitable mechanism, the pieces being of such shape that leather strips can be partly inserted in their place before they are completely withdrawn when the rim is filled, so that the leather is strongly compressed in the finished tire. Spiegel, E., Austria. Dated December 20th, 1909.

No. 15,963/10.—Knitting machines. Web-holders operated by cams are placed between and below the needle beds, and are connected by means of wires, to the pivoted needle-carrying jacks under control of the pattern drum. The needles and web holders may thus be moved simultaneously into or out of action with the respective cams. Grosser, G. F. (firm of), Saxony. Dated July 7th, 1909.

No. 16,171/10.—Grinding and polishing. Enlarging and trueing round holes. Relates to a method and apparatus for grinding and polishing perforated diamonds such as are employed for wire-drawing. The draw-stone to be operated upon is placed in a holder on a table carried by a rotating spindle, and the point of the grinding-pin which is supplied with abrading-material is inserted in the hole in the stone. Poppe, L., Berlin.

No. 16,258/10.—Electric cut-outs. In parallel-wire safety fuses comprising auxiliary wires which melt after the main fuse wires, a conductor, such as iron, having a high positive temperature co-efficient and a resistance at white heat at least ten times as great as when cold, is employed for the auxiliary wires, the rapid increase in its resistance causing a considerable reduction in the current at the moment of fusion. The main fuse may consist of silver, lead, copper, or other metals or alloys. The wires may be protected in the usual manner by insulating coverings or partitions, and filling material such as sand may surround them. Kallmann, M., Berlin.

No. 16,339/10.—Shaft couplings. In flexible couplings particularly applicable for driving magneto-electric ignition machines for internal combustion engines, the shaft carries a projection through which is passed a magazine of blade springs provided with side plates of fibre, vulcanite, or the like. One or each end of the magazine engages a slot in the rim of a plate secured to the other shaft. Honold, G., Germany.

No. 16,340/10.—Securing couplings on shafts. Relates to means for securing to their shaft couplings of the kind described in specification 16,339/10, which are employed to drive magneto-ignition machines from the internal combustion engines with which they are used. In order that the motor shaft and the ignition armature shaft may have a definite relative angular position, the coupling part is bored to receive a cylindrical bolt which is slotted to fit the ignition armature shaft. The bolt is then so far tightened by its nut that the coupling part turns with difficulty on the shaft. The shaft and coupling part are next relatively adjusted to their correct positions, and the bolt is so tightened as to secure them together. A tangential slot is then bored or filed in the shaft and a taper bolt inserted, so that the shaft and coupling part are positively secured together. Honold, G., Germany.

No. 16,615/10.—Liquefying hydrogen. Hydrogen is liquefied, without the aid of a liquefied subsidiary gas, by cooling the compressed gas to about 80 deg. Cent.—the temperature at which a further reduction of its temperature is possible by expansion with the performance of internal work—and allowing it to pass through an expansion nozzle, the cooling being effected by the expansion of cooled compressed air or hydrogen in a separate circuit. Heylandt-Ges., Germany. Dated July 12th, 1909.

No. 16,768/10.—Steam separators. Steam separators are provided with means for preventing oil from returning to the separating chamber and for purifying the separated oil by removal of the water contained therein. Further, the separator is combined with the condenser in such a manner that the steam in this surrounds the separator, thereby preventing condensation in the separator. Muchka, J., Vienna. Dated August 17th, 1909.

No. 16,902/10.—Ordnance; field carriages; recoil apparatus.—Relates to detachable trail spades, and consists in an arrangement whereby the spade is attached by moving the trail longitudinally on to it, and which, when connected, permits the trail to be traversed upon the spade for lateral aiming. Krupp Akt.-Ges., F. Germany. Dated October 12th, 1909.

No. 16,942/10.—Periscopes. In a periscope having a rotary reflector, the reflector is mounted in a light tube rotatable in a massive casing, which is provided with a transparent extension surrounding the reflector. Optische Anstalt C. P. Goerz Akt.-Ges., Berlin-Friedenau. Dated December 17th, 1909.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters: Balderton-street, Oxford-street, W.

ORDERS

For the week by Lieut.-Col. C. D. Clay, V.D., Commanding.

Officer for the Week.—Commander C. Campbell.

Next for Duty.—Platoon Commander A. Gerard.

Monday, July 9th.—Technical Instruction for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, July 10th.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday July 11th.—Drill, No. 1 Company, Right Half Company.

Thursday, July 12th.—Drill, No. 2 Company, Right Half Company. Ambulance Class, 6.30. Signalling.

Friday, July 13th.—Technical Instruction for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Saturday, July 14th.—Commanding Officer's Parade, 2.45. Uniform, for Drill in Hyde Park.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies see Notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters.

The Seniority of N.C.O.'s in No. 3 Company is as follows, and not as published in the orders dated June 14th.

Sergeants.—Jantzen, P. H. H.; Golding, H. J.; Fyfe, J. W.; Smith, J. M.

Corporals.—Ismay, W.; Scott, G. J. D.; Wood, H. G.; Cross, W. J.

Acting-Corporals.—Gillespy, J. T.; Salisbury, A. E.; Langford, W.; Brookes, J. W.

MACLEOD YEARSLEY,
Adjutant.

June 17th, 1917.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. C. H. RIDSDALE, F.I.C., F.C.S., &c., has retired from the position which he held for over thirty-four years as metallurgical manager and chief chemist to the North-Eastern Steel Company, Limited, Middlesbrough, and has joined Messrs. Ridsdale and Co., metallurgical and consulting analysts, of the same town.

THE editorial offices of the *Electrician* are now at 8, Bouverie-street, Fleet-street, E.C. 4, and not at Salisbury-court. The telephone number is City 9853, and the telegraphic address Benbrotric, Fleet, London.

FORTHCOMING ENGAGEMENT.

SATURDAY, JULY 7TH.

ASSOCIATION OF MANAGERS OF SEWAGE DISPOSAL WORKS.—Guildhall, Worcester. Annual summer conference. 11 a.m.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, the 2nd inst., the Duke of Northumberland, K.G., President, in the chair. Messrs. F. E. Robotham and R. D. Pullar were elected members of the Royal Institution.

THE INSTITUTE OF METALS.—The Council of the Institute of Metals announces that an extra election of members will take place on July 18th. Those desirous of applying for membership of the Institute are invited to write to the Secretary, 36, Victoria-street, Westminster, S.W. 1, for a copy of the new membership booklet, comprising 88 pages, which includes an up-to-date list of the Institute's 1760 members. The membership of the Institute has recently shown a very considerable increase, more additions to the roll having been made during the past six months than in the previous three years. The annual autumn meeting will be held on Wednesday, September 19th, in the rooms of the Chemical Society, Burlington House, London, W. 1.

SYNTHETIC INDIGO.—An entertaining account of the difficulties which had to be surmounted by the chemists of this country engaged in the production of dyes, is given in an article by Dr. G. T. Morgan, on "Synthetic Indigo," in the *Manchester Guardian* of June 30th. The author describes the methods adopted by a well-known German firm to evade the Patents Act of 1907, in connection with the manufacture of synthetic indigo at Ellesmere Port. When these works were taken over by British owners after the war broke out, one of the principal ingredients used in the manufacture of the dyes, namely, phenylglycine was unobtainable, so that before indigo could be produced phenylglycine had to be made. Then it was found that chloroacetic acid, a reagent employed in the German process for phenylglycine, had been commandeered by the Government. It thus became necessary not only to make phenylglycine, but to produce it without chloroacetic acid. This was done by an alternative process, and within six weeks large supplies of phenylglycine were available. The author says that the Ellesmere Port factory is now turning out more synthetic indigo than was ever the case under the old foreign régime, and the present requirements of the country for synthetic indigo are being adequately met. This result has been of the greatest benefit to the textile trades in general, and especially to those Admiralty and War-office contractors to whom indigo is the one really satisfactory colouring matter.

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[VOL. CXXIV.—No. 3211] LONDON: FRIDAY EVENING, JULY 13, 1917. [PRICE {WITH SUPPLEMENT} EIGHTPENCE BY INLAND POST TENPENCE

THE MANCHESTER MUNICIPAL

SCHOOL OF TECHNOLOGY

(UNIVERSITY OF MANCHESTER)

PRINCIPAL: J. C. M. GARNETT, M.A. (late Fellow of Trinity College, Cambridge).

The Session 1917-1918 will open on 5th October. Matriculation and Entrance Examinations will be held in July and September.

The Prospectus, forwarded free on application, gives particulars of the courses leading to the Manchester University degrees in the Faculty of Technology, and of the provision for Advanced Study and Research in the following departments:—

MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING,
SANITARY ENGINEERING (including Municipal Engineering),
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Bleaching, Dyeing and Dyestuff Manufacture, Printing, Papermaking, Brewing, and Metallurgy),
THE TEXTILE INDUSTRIES,
PRINTING AND PHOTOGRAPHIC TECHNOLOGY.
MINING,
ARCHITECTURE.

Intending students may enrol for the Session 1917-18 from 1st August, 1917. Members of the University under 18 years of age are eligible for membership of the Officers' Training Corps. 17 1

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M. Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE
comprising
FACULTIES OF ENGINEERING AND METALLURGY.

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Mining	F. E. ARMSTRONG, M.Sc., A.M. Inst. C.E.
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Mathematics	A. H. LEAHY, M.A.
Physics	S. R. MILNER, D.Sc. (Acting Prof.)
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139 Registrar.

University of Birmingham.

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ASSISTANT ENGINEER WANTED. Wages £2 10s. per week, with cottage, coal, and light.

Applications, stating age, qualifications, and experience, with copies of testimonials, to be sent to the
130 MEDICAL SUPERINTENDENT.

City of Oxford.—Wanted Immediately

at the Sewage Pumping Station, Littlemore, three miles from Oxford, a SECOND ENGINEER, to take alternate charge under the Resident Engineer of pair of beam engines and pumps.

A house on the site is provided rent free, with coal, light, &c. Sealed applications, endorsed "Pumping Station," stating age, qualifications, previous experience, and wages required, must reach the CITY ENGINEER, Town Hall, Oxford, on or before Wednesday, the 18th July instant.

Candidates must be ineligible for military service.
Dated 5th July, 1917. 123

South Staffordshire Waterworks Company.

Applications are invited for the position of CHIEF ENGINEER of the above Company. Applicants are requested to state previous experience and to send copies of testimonials to the SECRETARY, at the Office of the Company, Paradise-street, Birmingham, not later than 21st July, 1917. 83

Wanted, Assistant Works or

WORKS MANAGER, of a progressive nature, thoroughly conversant with sheet and plate metal manufactures; good knowledge of press work, works organisation, and plant lay-out essential; a judicious disciplinarian; immediate or post-war engagement. Give full particulars, age, experience, qualifications, salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 108. 108 A

Wanted, Builder's and Con-

TRACTOR'S AGENT. Must be thoroughly practical and used to superintending large works.—Reply, stating experience, age, references and salary required, P806, "The Engineer" Office. P806 A

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WORKS MANAGER with good all-round knowledge of Engineering Trade and up-to-date methods. Must be 6 o'clock man. Give particulars of experience, age and salary required. No person employed on Government work will be engaged.—Apply to nearest Employment Exchange, quoting "The Engineer" and number 72. 72 A

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NEER for Iron Ore Mines, Bye-Product Coke Oven Plant, Blast Furnaces and Steel Works. Good salary paid to suitable man.—Reply, stating age, experience, &c., to REDBOURN HILL IRON and COAL CO., Ltd., Scunthorpe, Lincolnshire. 164 A

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of ELECTRICAL PLANT, Wiring, &c., in large Engineering Works in Eastern Counties. State age, experience, and wages required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3380. 75 A

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WANTED in old-established Aeroplane Factory (controlled firm). Must be willing to put in full workmen's hours. Financial interest may be arranged if preferred. Must have up-to-date knowledge of Modern Factory Methods, and be an excellent man upon Production. Works are about 30 miles from London, and are equipped with up-to-date plant. Good salary offered to a competent man.—Address, in first instance, giving fullest possible particulars of experience, age, and qualifications, to 132, "The Engineer" Office. No one at present engaged upon Government work need apply. 132 A

Engineer Assistant Required by

Westminster Firm of Engineers working on urgent war work. Must have experience in working out estimates, tenders, taking out quantities and the checking of drawings. Give particulars of practical and theoretical training. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 126. 126 A

Engineer Required on Govern-

MENT service (not of a Military nature, although Commission would probably be given). Experience necessary: knowledge of Works Management, Manufacturing Organisation and Production. Special knowledge of Machine Tools and their economic employment desirable.—Apply, Box 701, Caxton Advertising Agency, Clun House, Surrey-street, London, W.C.2. 125 A

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Abroad to Supervise Refrigerating Machines. Experience with Ammonia desirable. No one engaged on Government work or eligible for the Army need apply.—Send copies of testimonials to "T." Box 272, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 127 A

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for Special Department used to designing Special Machinery. A good man would have rapid advancement.—Address, 151, "The Engineer" Office. 151 A

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The Pumpherston Oil Company,

LIMITED.

WANTED, a thoroughly qualified MANAGER to undertake the general management of a section of this company's Mines and Crude Oil Works. Applicants must have a sound theoretical and practical training, with good experience of mining work, combined with knowledge of mechanical and electrical engineering.

Applications to be sent to the SECRETARY of the Company, 135, Buchanan-street, Glasgow. P805 A

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Managing Director (Colonel R.E. retiring from active service) to re-open Westminster Offices, Consulting Engineers, with important undertakings waiting developments. Also as a going concern, provincial business, Engineers and Contractors, with modern specialities. Businesses established over 20 years. Influential connections; qualifications, £3000 each, Directors having option to nominate Staff Assistants.—For preliminary interview, Principals only, address, P795, "The Engineer" Office. P795 A

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ERAL Metallurgical Analysis. No person already engaged on Government work eligible.—Apply, stating full particulars to your nearest Employment Exchange, quoting "The Engineer" and reference No A3356. 27 A

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DETAIL DRAUGHTSMEN, preferably experienced in Cranework. Permanency for suitable men. State full particulars of experience, age, salary, and when can commence. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 160. 160 A

Wanted, Several First-class

MECHANICAL DRAUGHTSMEN with good all-round experience for Admiralty work.—Apply (by letter only), stating age, experience, and present salary, to Box No. 1154, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C.4. 30 A

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Draughtsman, Junior, Mechan-

ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3354. 12 A

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ENCED in Light Railway Rolling Stock and Locos. State fully experience, salary, &c. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 171. 171 A

Draughtsmen.—Some Experi-

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NEERING Firm for most urgent work in connection with Shipbuilding. Applicants must have had experience of marine engines or turbines for propelling purposes. Only those not on Government work considered.—State age, experience, and salary required to your nearest Employment Exchange, quoting "The Engineer" and number 41. 41 A

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ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 A

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Reinforced Concrete Work WANTED IMMEDIATELY, London, W.1. No person already employed on Government work or residing more than 10 miles away will be engaged.—Apply, stating age, experience, and salary required, to 166, "The Engineer" Office. 166 A

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QUIRED for Aviation Works near London. Good man required. No person resident more than 10 miles away or already engaged on Government work need apply. State age, salary and experience.—Write, Box 560, Samson Clark and Co., Ltd., 56, Great Portland-street, W. 1. 118 A

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Write, stating age, salary, and full details of experience, to Box 113, c.o. Mitchell's Advertising Agency, 1, Snowhill, E.C. 1. P787 B

Several Lady Tracers Required

for South of England, accustomed to high-class engineering work. Apply (by letter only), stating age, experience, present salary, and if possible enclose sample of work, to Box No. 1150, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C. 4. 29 A

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MEN REQUIRED immediately for important War Work; also DETAILERS and TRACERS, with experience in Steam Plant, Conveying Plant, and general factory work. No person already engaged on Government work need apply.—State full experience, when at liberty, and wages required to your nearest Employment Exchange, quoting "The Engineer," and No. A3451. 173 A

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WANTED, by large Firm in North of England, who have had experience in Turbine Design. JUNIORS also REQUIRED. No person already engaged on Government work can be considered. Positions permanent.—Apply, stating age and salary required, to your nearest Employment Exchange, quoting "The Engineer" and number 842. 842 A

Two Experienced Mechanical

DRAUGHTSMEN, preferably with knowledge of internal combustion engine work, but not absolutely essential. Prospects good but not merely for duration of war. Applicants must be ineligible for military service. Government work. London district.

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Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P746. P746 A

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FOREMAN for a large Government controlled establishment in the West Riding of Yorkshire engaged exclusively on Government contracts.

Applicants should have held a similar position in the tool room of a large works engaged on repetition work, and should be capable of controlling labour and taking entire charge when necessary, and should have had experience in the manufacture of small tools, jigs and fixtures.

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Apply, stating age, full particulars of past experience, and salary required, to your nearest Employment Exchange, and quoting "The Engineer" and No. A3396. 121 A

Wanted for Large Engineering

Works in Midlands, FOREMAN for Brass Turning and Finishing Department; must be conversant with modern plant and repetition work. State age, experience, and remuneration required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3362. 76 A

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WANTED immediately for Modern Machine Shop, London, W. About 150 machines. Capstans, Gridley, New Britain, "B and S" autos. Good opportunity for man 25-35 having suitable experience who has not held such a responsible position before. Permanent and progressive position to the right man. Shell experts, or men at present engaged on Government work, and residing more than 10 miles away, need not apply.—Address, stating age, experience, and wages required, to 167, "The Engineer" Office. 167 A

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QUIRED for Engineering Works, East Coast. Preference given to person having experience in Internal Combustion Oil Engines. Must be accustomed to high-class work and quick methods of production. Good salary to capable man. No person on Government work will be employed except by consent of present employer.—Apply, with fullest possible particulars, to nearest Employment Exchange, mentioning "The Engineer" and number 120. 120 A

Machine Shop Foreman Wanted

for small machine shop. Applicants should be used to general engineering and be able to produce accurate work by quick and up-to-date methods. Permanent position to a suitable man. No man at present employed on Government work will be engaged.—Write or call at your nearest Employment Exchange, giving "The Engineer" and number 133. 133 A

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charge of London Office of Provincial Engineering Manufacturers.—Full particulars of experience, age, salary and testimonials to 134, "The Engineer" Office. 134 A

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London Manufacturer for each—Clyde, Tyne, Leeds and Birmingham districts to Introduce Drawing-Office Materials. Splendid extra commission for gentleman well in.—Address, in first instance, P812, "The Engineer" Office. P812

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large works in the Midlands, producing Wrought and Cast Ironwork; permanent situation. Practical Works knowledge and previous experience in Costing essential. No person already on Government work will be engaged.—Apply, stating full particulars and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3238. 163 A

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in London, experienced BORERS, TURNERS, DRILLERS, VERTICAL and HORIZONTAL MILLERS, and TOOLSMITHS. No one already on Government work can be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3381. P760 A

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MANAGER or FOREMAN (Diesel, Oil or Gas Engine Works); Fitting and Erecting preferred. Had extensive all-round experience and previously held similar position. Will be highly recommended.—Address, P788, "The Engineer" Office. P788 B

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Inspecting Engineers, Estab- LISHED over 20 years in Midlands, with qualified staff can UNDERTAKE TESTING and SUPERVISION, Electrical Plant, Structural Work, Bridgework, Rolling Stock, Machinery &c.—Address, P288, "The Engineer" Office. P288 I

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Wanted.—The Pioneer Electric CO., 22, Churchgate-street, Fort, Bombay (India), DESIRES CONNECTION with DEALERS in SECOND-HAND MACHINERIES—Electric, Boilers, Oil, Steam or Gas Engines, &c. P791 D

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Wanted, Boilers, Economic type, 14ft. × 8ft., 150 lb., or near size; Ditto, Lancashire type, between 120 lb. and 150 lb.—A. UNDERWOOD, 3, Queen-street, E.C. 169 F

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THE LATENT HEAT OF STEAM.

By FRANK B. ASPINALL., M.I.E.E.

No. II.*

THE FINSBURY DETERMINATION (*continued*).

In last week's article the apparatus used in the determination of the Latent Heat of Steam at the Technical College, Finsbury, was described. The investigations made have now to be dealt with.

METHOD OF EXPERIMENT.

The wood in the barrel used was as dry as possible, as it had been standing in a dry place for some months.

It was made water-tight by a cooper, no water being used to swell the wood. The barrel in this thoroughly dry condition with the thermometers, guards and glands in position was found to weigh 158 lb. 15½ oz. Before the iron thermometer guards and glands were fixed in position, they were weighed, but it was considered more accurate to omit the plugs, as their temperature could be so little affected by the change of temperature of the condensing water.

The weight of the movable flange and iron pipe dipping under the condensing water, plus 1½in. above the maximum possible height of the water, was also ascertained.

The water value of the guards, glands, flange and this length of pipe was 1.089 lb., the specific heat of wrought iron being accepted as .114 between the limits of temperature worked at. The best method of keeping the temperature of the boiler-house at an even temperature, and the best position of the thermometer to measure the average temperature of the air surrounding the barrel, were ascertained by actual trial. The most satisfactory size of hole, through which to blow the steam into the condensing water, was decided after numerous plugs with various sized holes had been tested. During these trials the weight of steam condensed per minute, with the chosen size of hole, was ascertained. Trials were also made to see if Rumford's Correction could be relied upon as accurate. But it was found that for the same difference of temperature and the same air temperature, the temperature gained by the condensing water when it was below the air temperature was less than the temperature lost when the condensing water was above the air temperature. The heating trials showed that the temperature of the water throughout its mass was more even if the barrel was filled with the hose at the bottom instead of at the top. (A portable electric lamp was used, so that the thermometers could be read with great accuracy.)

When starting a trial, the water which was kept in the barrel as a safeguard against leakage was syphoned off and a known weight of the coldest obtainable water was run in. After the water had stood for about five minutes, the temperature of thermometer I., thermometer II. and thermometer III. were recorded. The water was again allowed to stand for as nearly as possible the same time as it took to raise the temperature of the water to the room temperature when steam was being blown in. The three temperatures were again recorded.

In the trials at 50 lb. the whirling of the water due to the steam being blown in was so slight that it was not considered necessary to stir the water during the heating test if the conditions were to be the same as in the actual trial.

In the trials at 100 lb. and 150 lb., however, the whirling was sufficient to cause an error; the condensing water was, therefore, made to whirl by circular stirring at the same rate as in the trial. In the trials, cooling tests were also carried out at the finish of the trial for the same time as it had taken to raise the condensing water from the air temperature to the final observed temperature. These tests commenced immediately the trials finished.

The temperature added to the final observed temperature was half the temperature lost during cooling, minus half the temperature gained during heating, as this was considered fairly to represent the temperature which the water would have gained during the trial, if it had not received heat from, or lost heat to the surrounding air.

It will be noticed that no correction is made for the alteration in the weight of water present, but this was not done because the rate at which the weight of water altered could not be ascertained. Calculation showed, however, that the error due to the weight of the water altering was negligible.

Whilst a heating trial was taking place, the valve controlling the admission of steam to the condensing water was kept closed. It may be mentioned that during all the trials the very greatest care was taken to make absolutely certain that this valve was steam-tight.

Steam, however, was being blown into the drain tub to warm everything up and get rid of air.

During the first series of trials at 50 lb. the fixed pipe was used, but in all the other trials the swivelling pipe was used instead. The pipe used slightly altered the procedure. With the fixed pipe an increase of weight was put on the scale arm and steam was blown in until the scale arm began to rise. The accuracy of this method of weighing had been previously proved by a check weighing with the pipe removed. The temperature of the condensing water was then recorded practically in half a minute, and the trial blow of steam was then commenced, the time being noted. The preliminary blow was to get rid of air in the pipe leading to the condensing water and to warm up the thermometer well and surrounding iron, as previous trials showed that, if this was not done, it would cause a considerable error. With the swivelling pipe, the pipe was turned up out of the water and steam was blown through at the test pressure before it was dropped into the water when the trial commenced, and it was turned up out of the water when the trial finished, the plug being removed to make certain that no water was left in the pipe. A swivelling pipe was used because the joint at the flange had not to be broken, so that the pipe could be emptied of water when the final weighing was made. But the chief reason for using a swivelling instead of a fixed pipe was lost, with the latter, heat might be received by the condensing water after the temperatures had been read before the blow commenced, and also heat might be received after the trial finished. It was desirable that the start and finish of a trial should be as definite as possible, and it was an advantage to be able to check everything twice.

After the first series of trials had been completed, and whilst the swivelling pipe was being made, the barrel was unintentionally allowed to stand empty for some days. This caused the wood inside the barrel to blister, crack and flake; but these blisters, &c., disappeared when the barrel was refilled with water, and had stood for forty-eight hours. Fortunately, none of the wood broke away. It was found that, after this accident, the wood absorbed a great deal of water, probably owing to the pores being opened which the previous residue had filled up. The wood was also found to absorb heat, so the water value of the wood was determined by a method of mixtures, and afterwards constantly checked to make sure that it did not alter.

THE TRIALS.

The most important part of the trials has now to be described. In all the trials the desired pressure at the point B was kept constant, but the super-temperature varied.

A super-temperature was always present whilst steam was being blown into the condensing water, except possibly for a short time at the commencement of the blow.

In the trials at 50 lb. and 100 lb., the desired super-temperature was obtained by raising or lowering the boiler pressure, the steam being wire-drawn to 50 lb. or 100 lb. by the controlling valve. In the trials at 150 lb. the super-temperature was obtained by passing the steam through the superheater, as the boiler could not be raised to a sufficiently high pressure. As the boiler had induced draught which could be varied between wide limits, the pressure of it could be very quickly raised, and when it was desired to reduce it the feed pump was put on if the dampers were not sufficient.

As it simplifies matters, the superheater would have been used in all the trials if the object had been simply to ascertain the maximum heat which could be latent or latent heat. But, after discussing the procedure with the late Dr. Silvanus Thompson, F.R.S., it was decided to show that, whilst latent heat is a constant, heat latent is a variable; that is, whilst the maximum heat which can be latent is a constant, the heat which can possibly be latent is a variable, which varies from a maximum to a minimum.

The temperature and pressure both before and after wiredrawing was, therefore, measured in the trials at 50 lb. and 100 lb. gauge, to show that, whilst the heat latent before the steam was dried was a variable, the heat latent after the steam had been dried by the act of wiredrawing was a constant. It was also considered an advantage to show that drying steam by wiredrawing is the same as drying steam by a superheater, as the author understands that this has been denied, but, by whom, he has been unable to ascertain.

The following was the formula used to work out the latent heat:—

The latent heat of steam at the pressure P at the point B

$$= \frac{W(t_1 - t_2) - w(T - t_1)}{w} + \text{or} - j.$$

P. As the super-temperature was so low, the observed pressure was accepted as the pressure of pure steam, but if the steam had been very highly superheated, a correction would have to have been made for the super-temperature.

W. In first trials. The water present at commencement of the second blow + the water value of the metal.

In second, third and fourth trials. The water present when the pipe was dropped into the water + the water value of the metal + the water value of the wood.

w. The actual weight present at the finish of the trial, minus the actual weight present at the commencement of the trial.

T. The mean corrected observed temperature of the thermometer in the long thermometer well – the mean super-temperature.

t_1. The mean corrected observed temperature of the condensing water at the finish of the trial, as shown by thermometers T.I., T.II., T.III. + the temperature the condensing water would have gained if it had not lost or received heat due to the surrounding air.

t_2. The mean observed corrected temperature of the condensing water at the commencement of the trial, as shown by thermometers T.I., T.II., T.III.

j. The difference between the superheat in the steam due to the super-temperature and the heat radiated from the lagged and bare pipe beyond the controlling valve admitting steam to the condensing water to within 1½in. above the maximum height of the water in the wooden vessel.

It will be noticed that the author, like Southern and Regnault, makes no correction for possible changes in the specific heat of the boiler water. It appears, however, from the results of James Watt, Southern, and the author, that the specific heat of water is a constant **when water is subjected to the conditions present when a boiler is making steam.*

DETERMINATION OF THE WATER VALUE OF THE WOODEN VESSEL BY THE METHOD OF MIXTURES.

The method employed was to place a known weight of water (a) in the wooden vessel at a temperature (b) practically equal to the room temperature, and then mix with this water a known weight of cold water (c) at a known temperature (d).

The temperature of the mixture if no heat is received from the wood

$$= \frac{(a \times b) + (c \times d)}{a + c}$$

The observed temperature of the mixture f was more than e, therefore $f - e$ equals the temperature gained by receiving heat from the wood, and the heat actually gained from the wood equals $(f - e) \times (a + c)$. The water value of the wood = (The observed temperature of the mixture – The temperature if no heat had been gained).

× by the actual weight of the mixture

Temperature of the wood – The observed temperature of the mixture,

or $$\frac{(f - e) \times (a + c)}{b - f}$$

Particulars of Trials.

	I.	II.
Mean temperature of room	77.5	75.8
Actual weight of vessel and water at commencement of trial	939.56	776.43
(a) Water value in vessel thermometer guards allowed for	781.0	617.87
(b) Average temperature of the water	77.2	75.4
Weight of tub and water after cold water added	1251.62	1250.25
(c) Actual weight of cold water added	312.06	473.82
(d) Temperature of cold water	49.25	58.25
(e) Temperature of mixture if no heat had been received	69.22	67.957
(f) Observed temperature of mixture	69.46	68.216
Water value of wood, pounds	33.89	39.36
Mean water value of wood	36.62	—

In a concluding article the results of the trials will be set out and discussed.

PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT.

By GEORGE KENWORTHY, Asso. M. Inst. C.E.

No. II.†

SECTION I.—PART II.

BUTT JOINTS IN BOOMS OF BRIDGES.

In the top members, or "top booms," as they are called, of the main girders of any large bridge, it is particularly desirable that the meeting pieces at a break in the boom should be made to touch or "butt" as near as possible. Butts are always specified, and sometimes are even reckoned on for the strength of the joint. Even in the highest class of work, however, actual touching throughout the faces of any two meeting members is seldom, if ever, attained, and certainly should not be reckoned upon in designing compression joints. Take, for instance, a large truss, as shown with its booms formed of double webbed boxes—see Figs. 7 and 8. At the point "A" a joint is always made, and this is perhaps the most important connection of the whole frame Two ways are adopted in order to get the two members meeting at "A" to form a good joint:—(1) By planing and sawing respectively the component parts of the box separately, and then by building the parts up to as square and correct an angle as is possible. (2) By building the boxes with the ends left in the rough, and, after riveting, placing the whole box on a machine with a revolving face plate,

* No. I. appeared July 6th.

* I am aware of the table given by Barnes (*Phil. Trans.*, 1902) at the end of his paper on "The Capacity for Heat of Water between Freezing and Boiling Points," where he gives numerical values stating that the specific heat of water increases from 1.0074 to 1.0384, when the temperature is raised from 100 to 200 deg. Cent. But these figures are purely extrapolated from experiments in which the temperature never exceeded 96 deg. Cent., and which could not possibly exceed 100 deg. Cent., as this was the boiling-point of the water. His experiments also afford no criterion as to the specific heat of water actually boiling, or boiling under boiler conditions, where it can boil at any temperature from 0 to 200 deg. Cent., provided the boiler pressure permits it to do so. Hence his values are inadmissible when considering the specific heat of the boiler water. The extrapolation of Barnes assumes the very point here challenged, that a pressure exerted on or by the water has no effect on its capacity for heat. The facts appear to support the conclusion that water, like steam, has different specific heats for different conditions, such as (a) constant pressure and a varying temperature, (b) pressure varying with the temperature

† No. I. appeared July 6th.

with cutters attached—the boom first of all being set to the right angle required.

In the first method it is quite usual for the flange, say, to overhang the web, or one web to have a lead on the other, in the finished box—in that case allowance is made by a shortening or lengthening of the corresponding part on the box which meets it. It is needless to enlarge on the difficulties during manufacture, which make it practically impossible to get a joint made in such a way to butt perfectly. The second method is far in advance of this, but even by the method of facing the whole joint together inaccuracies arise. There is a certain spring in the facing cutters, in the face plate, and in the spindle of the machine, which gives way to the cutters when they are acting on the greatest areas, *i.e.*, when passing over the webs and main angles. This spring is at a minimum when the cutters pass over the single flange, and thus a slight concave cut is put into the flange—see Fig. 8. Or it may be that the box may be set a little out of its correct position on the machine,

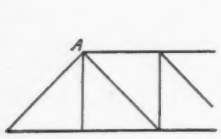


Fig.7.

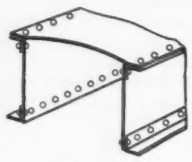


Fig.8.

"THE ENGINEER" SWAIN Sc.

which, of course, would at once show itself when the joints came together. It would be as well to allow a slight draw on the holes in the ends of the boxes, so that "a pull" could be got from the tackle when the joint was being formed. For instance, if the holes in the connecting gusset plate were 3in. across centres, the corresponding holes in the boxes should be 3/2in. + 1/32in. = 1.17/32in. from the ends. Very good joints can be, and actually are, got by great care being exercised; but a "feeler" can always be got in at places, proving that the best of joints are only bearing at points.

THE DESIGN OF STRINGERS AND CROSS GIRDERS IN RAILWAY BRIDGES.

Stringers, or rail girders, are usually designed as if they were girders of freely-supported ends. The opinion seems to be that if these girders are so considered in design, then, because a freely supported girder would have a greater bending moment at the centre than if it were of fixed ends—with the same axle loads, of course—it is safe to design it as such, and to assume that no greater stresses than are calculated from this assumption will obtain. It is intended to prove that this reasoning is not correct.

The usual method is to find the greatest axle loads which will come on to the stringers, to allow on these

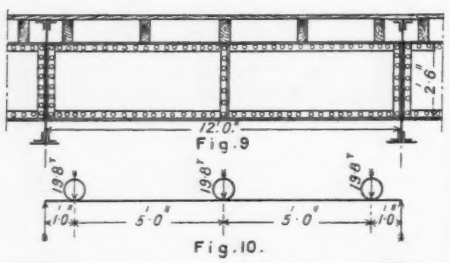


Fig.9

Fig.10.

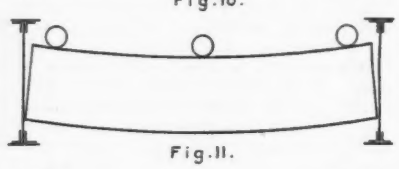


Fig.11.

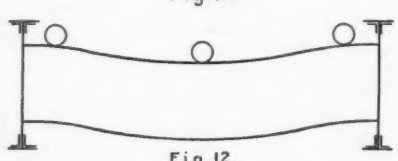


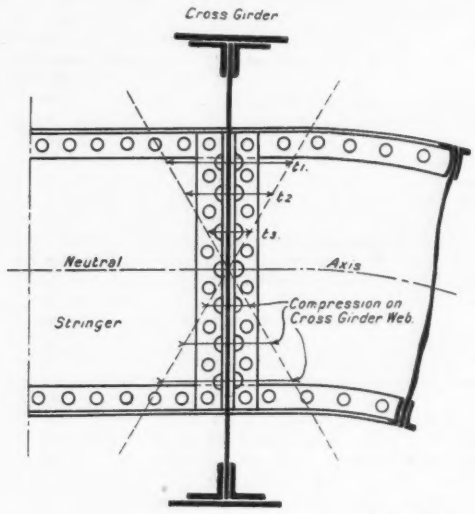
Fig.12.

"THE ENGINEER" SWAIN Sc.

loads a percentage for impact, and to place one, or a greater number of wheels, according to the length of the stringer, in such a position as to cause the greatest bending moment. After this has been done the bending moment due to an evenly distributed load of the deadweight of the girder and permanent way is added. Consider such a girder as is shown in Fig. 9. It is of quite probable dimensions, and the ends are attached to the cross girders by the usual attachment, *i.e.*, with angles riveted to both stringer and cross girder. Assume that the girder is to be designed according to Cooper's Standard Loading, "E 45." The maximum live load would then be three wheel loads of 10.1 tons each, at 5ft. centres. Assuming an allowance for impact taken from an American formula much used in this country, we get

$$\left\{\frac{300 \times 100}{L + 300}\right\} = 96 \text{ per cent.} = 9.7 \text{ tons (additional)}$$

on each wheel load. (The effects of dead load may be ignored for this example.) The loading would then be as in Fig. 10.



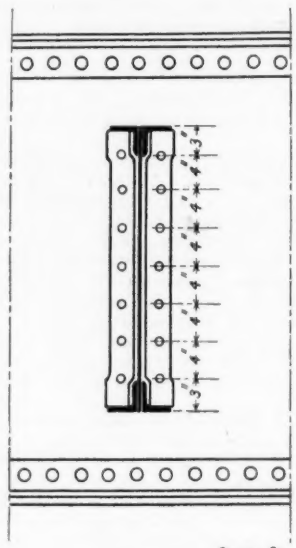


Fig.13.

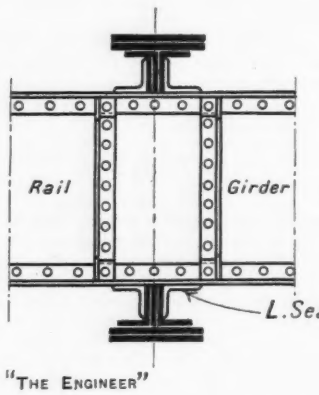
"THE ENGINEER" SWAIN Sc.

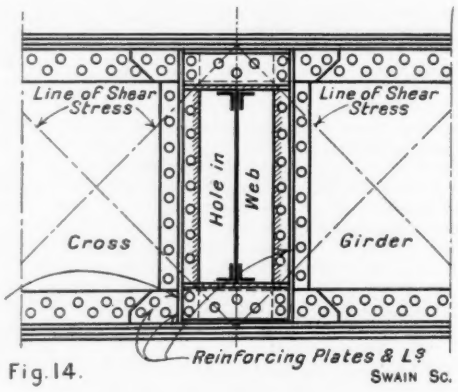
The maximum bending moment (if beam were freely supported at ends)

$$= 29.7 \times 6 - 19.8 \times 5$$
$$= 79.2 \text{ tons-feet (at the centre of the girder).}$$

$$\text{Flange stress} = \frac{\text{bending moment}}{\text{effective depth}} = \frac{79.2}{2\frac{1}{4}} = 35.2$$

tons. But for this condition of things to exist the girder should be free to bend as in Fig. 11. Actually,





"THE ENGINEER" Fig.14. SWAIN Sc.

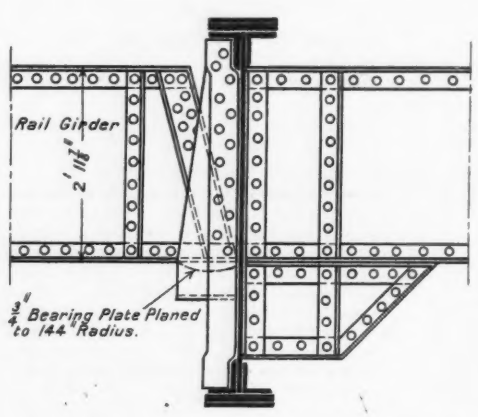
however, the girder can only bend as in Fig. 12, *i.e.*, conforming to the condition of fixed ends. Referring to loading diagram—Fig. 10—the bending moment at each support, with fixed ends, as shown in Fig. 12, would be :—

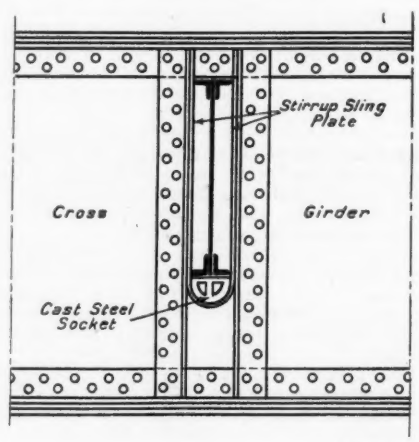
$$\text{B.M.} = \frac{19.8 \times 11^2 \times 1}{12^2} + \frac{19.8 \times 1^2 \times 11}{12^2} + \frac{19.8 \times 12}{8}$$

$$= 48 \text{ tons-feet, and flange stress} = \frac{48}{2\frac{1}{4}} = 21.4 \text{ tons.}$$

(If the girder were considered as one of a series of continuous girders, over a number of spans equal to the number of panels of the bridge, a lower bending moment would be calculated; but the axle loads on one stringer of fixed ends give a result more consistent with what actually takes place.)

Fig. 13 shows a large detail of the end connection. The rivets are spaced to suit a usual working pitch. Actually they would be designed to take the maximum shear stress, but in the case considered there is quite a generous allowance of rivets—it will often be found that for pure shear stress there are more than enough rivets. In the same way as the material above the neutral axis is in tension, and that below in compression, so also there is a pull in the rivet heads above the neutral axis, and a compression on the web of the cross girder below the neutral axis, indicated by, and proportional to, the lengths of the arrows in the sketch.





"THE ENGINEER" Fig.15. SWAIN Sc.

Let t_1, t_2, and t_3 be the tension in the pairs of rivets respectively, counting from the top outer pair. There will be no pull on the rivet at the neutral axis. The compression below the neutral axis does not enter into these calculations. Then the tension in the rivets effected (above N A) × number of rivets horizontally × distance in feet to neutral axis = half total bending moment at the support.

$$(t_1 \times 2 \times 1) + (t_2 \times 2/3 \times 2) + (t_3 \times 1/3 \times 2) = \frac{48}{2}$$

$$2t_1 + \frac{4}{3}t_2 + \frac{2}{3}t_3 = 24.$$

As the intensity of stress varies as the distance from the neutral axis, then

$$t_2 = \frac{2}{3}t_1,$$

and $t_3 = \frac{1}{3} t_1$,

$$2 t_1 + \frac{8}{9} t_1 + \frac{2}{9} t_1 = 24,$$

$t_1 = 7.7$ tons pull per rivet.
$t_2 = 5.1$ " "
$t_3 = 2.6$ " "

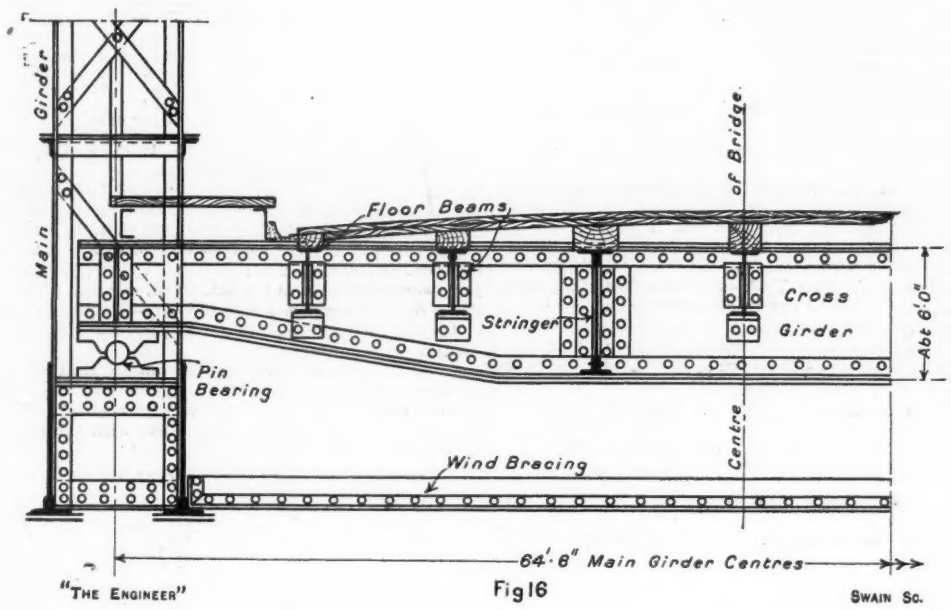


Fig 16

In addition to the stress found above, there is the pure shear stress; and a resultant of the two (arrived at by the same method as is explained earlier) must be considered.

It is plain from the above reasoning that whether a rail girder is designed as such or not, it is to a large extent a girder of fixed ends, and that the usual construction is highly unsatisfactory, producing intense stresses in the riveted ends, which are not taken into account. It would seem, then, that either the girders should be designed as continuous girders, and their ends made so as to meet any excess of stress—a fair amount of material would then be saved—or be so arranged that their ends are actually as they are assumed to be, *i.e.*, free.

In theatre steel work it is quite usual to run the radial stringer joists right through the webs of the main supporting girder, thereby greatly enhancing the strength of the former. It is suggested here that a similar practice might be followed by making the rail girders run through the webs of the cross girders—as in Fig. 14.

A novel feature is introduced in the stringers between spans of the Lower Ganges bridge, Sara, India—Fig. 15. By some such means as this—although not the object in the example shown—the rail girders may be made to satisfy the conditions of design. Cross girders are also subject more or less to the above criticism, and attempts have been made to overcome the disadvantage of fixing the ends, but without much success as yet. Fig. 16 shows the cross girder connections of a bridge in existence in Holland under the administration of the Dutch State Railways.* The weakening of the bridge laterally, owing to the wind bracing not being connected to the cross girders, and to the latter giving no support to the main trusses, is a serious disadvantage.

FAULTY ATTACHMENT OF TENSION MEMBERS.

Fig. 17A shows a common connection for the main ties in a roof truss. An angle, 3in. × 3in. × ½in., is used for the principal tie, and is attached by ⅞in. rivets. A safe tensile stress of 7½ tons is assumed. The total stress must be transmitted towards the end of the bar into the one leaf which attaches to the rivets, and thence to the rivets themselves. The nett area of attached leaf equals 1.03; area of unattached leaf equals 1.25; total nett area 2.28 square inches. The actual stress in the attached leaf, instead of being 7½ tons per square inch, is equal, then, to $7\frac{1}{2} \times 2.28 \div 1.03 = 16.6$ tons per square inch. It may be argued that the stress is not all transmitted from one leaf to the other at one point, but that, as each rivet is passed, working nearer to the end of the bar, so the tensile stress is reduced by the shear stress in the rivets behind it. There is little doubt, however, that the lines of stress from the two leaves converge before the connection is reached. In any case this—which is a very common detail for connecting tension bars in various structures—is very faulty, and the correct attachment is shown in Fig. 17B.

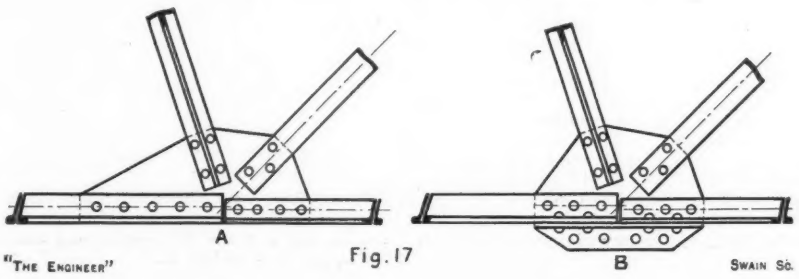


Fig. 17

BRACING RODS (WITH TURNBUCKLES) USED AS WIND BRACING.

A building in which this method of bracing is used is shown in Fig. 18. In designing this bracing it is usual to assume that the horizontal shear load from the wind is divided equally into the number of bays. Assume that 1½in. diameter rods with turnbuckles have been used—area at the bottom of thread = 1.3 square inches; assume 7½ tons per square inch safe tensile stress. These rods are tightened up by means of the turnbuckles, and it is safe to say that the tension thus applied to the different rods is never equal. Consider the amount of this tension; assume that, after the rod is drawn perfectly straight from point to point, the turnbuckle is further tightened by one-half turn; then the rod will be shortened by one full pitch of the thread. For an 1½in. diameter rod this equals ⅛in. Assume that the length of the rod is 20ft., then the stress $= \frac{E \times \frac{1}{8}}{240} = 9\frac{3}{4}$ tons per square inch. Now, the rod in the bay which has been most tightened will be the one which, due to this tightening, takes practically all the working load. For the system of bracing shown in sketch the tightened rod would take four times the safe working load, and, added to this, would have the initial tension due to the tightening up. This gives a total unit stress equal to $(4 \times 7\frac{1}{2}) + 9\frac{3}{4} = 39\frac{3}{4}$ tons per square inch, which, of course, is more than the breaking stress. This type of wind bracing—and it is still common—is neither safe nor satisfactory, and probably the only reason which keeps many light buildings from actual collapse is the fact that they are sheeted with corrugated sheets, which act like a solid web plate. Of course, with such sheeted buildings the stress of 39¾ tons never actually exists in the rods, the latter being little more useful than for squaring the building up during erection—whilst the sheets themselves take the actual shear due to the horizontal wind load. The dangers which are noted here due to tightening one member more than another do not only apply to tie-rods, though the danger is much more likely to be found in rod bracing. Extra tension or compression—as well as bending, which is dealt with later—is put into many members of rigid frames by means of injudicious drifting. Only accurate work, carefully marked off and skilfully plated, will avoid the dangers at this stage.

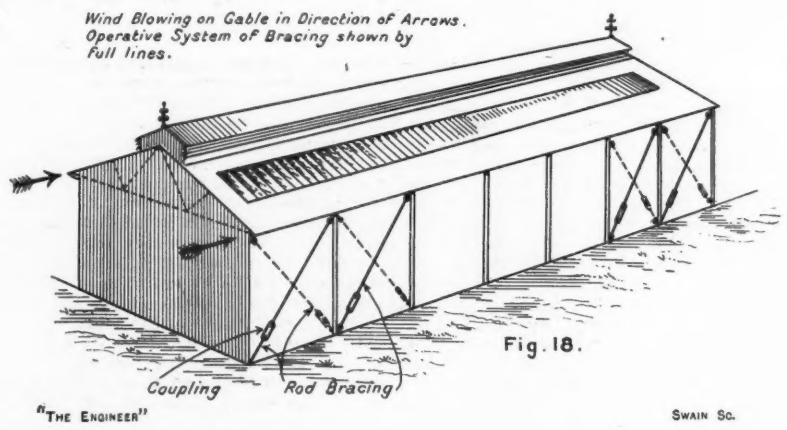


Fig. 18.

* This figure is adapted from an illustration in Mr. M. W. Davies' book on "Structural Design."

THE USE OF WASTE GASES FOR STEAM GENERATION.

By JOHN B. C. KERSHAW.

THE utilisation of the waste gases from coke ovens and furnaces generally for steam generation has progressed rapidly in recent years, and had not the war checked development in many industries, still further progress would have been recorded.

In view of the industrial struggles ahead, and the necessity that exists for utilising our fuel resources to the greatest possible extent, it will be useful to study the progress and records of the past few years, in order to show what economies are possible by aid of waste heat boilers.

The heat carried away in waste gases may exist either as "sensible heat," *i.e.*, heat measurable by the thermometer, and due to the failure to extract from the gases the whole of the heat generated by the combustion of the fuel, or as "potential heat," *i.e.*, heat represented by chemical energy, due to the incomplete oxidation of the combustible matter, and to the presence of hydrogen and carbonic oxide in the escaping gases.

In the latter case, some form of burner and combustion chamber, with means for regulating the air supply, is necessary, whereas when the waste gases carry only "sensible" heat, and combustion is completed, the addition of a boiler only is required to save some portion of wasted heat.

In the earlier installations of waste heat boilers, the natural chimney draught was relied upon to overcome the increased resistance due to the passage of the gases through the flues of the boiler. In many cases the boiler was erected directly above the furnace, in order to minimise the losses from this cause. This plan was never entirely satisfactory, and in modern installations artificial draught is always employed. In this way the draught of the original apparatus or furnace is increased rather than lessened by the installation of the waste heat boilers, and the use of the fans also enables much higher gas velocities to be attained over the water-cooled plates of the boiler, and increases considerably the rate of heat transmission, and therefore the efficiency of the whole plant. As regards the practical value of waste heat boilers, it is possible with a modern plant to reduce the heat of the waste gases to 500 deg. Fah. Any furnace, therefore, which is allowing gases to pass away above this temperature, may be provided with the necessary plant for recovering the waste heat, although as a general rule it

only pays to recover the heat when the gases are carrying 200 deg. or 300 deg. Fah. of surplus heat up the chimney.

In the United States it is calculated that the utilisation of the waste heat from open-hearth and other regenerative furnaces in the steel-making plants is equivalent to a saving of 250 lb. of coal per ton of ingots produced, or to an annual saving of two million tons of fuel. Of the toal heat delivered to the open-hearth furnace, 45 per cent. is wasted in chimney losses, and from one-half to two-thirds of this heat can be recovered by the installation of waste heat boilers.

The following tabular statement shows the chemical composition, thermal value, and "sensible" heat of the waste gases from typical iron, steel, and other metallurgical furnaces.

TABLE I.—*The Chemical Composition and Thermal Value of Waste Gases containing Combustible Constituents.*

Type of gas.	Per cent. H.	Per cent. CH_4	Per cent. CO.	Per cent. C_2H_2.	Calorific value.*
Coke-oven gas ..	49.1	32.6	8.1	3.1	535
Blast-furnace gas ..	3.5	—	25.4	—	90 to 115

* In British thermal units per cubic foot of gas.

TABLE II.—*The Sensible Heats of Waste Gases containing no Combustible Constituents.*

Source of gas.	Temperature, deg. Fah.
Open-hearth steel furnaces	1100–1300
Reheating furnaces	1100–1900
Cement kilns	1300–1800
Copper refining furnaces	1400–2200

The following practical examples of waste heat utilisation for steam generation are drawn from the United Kingdom, Belgium, Germany, and the United States; those examples being selected in which the data of test results are the most reliable and up to date.

UNITED KINGDOM.

Although small isolated installations of boilers utilising the waste heat from coke ovens and blast-furnaces, or from furnace operations in chemical works, had existed in the United Kingdom prior to 1907, the most notable development occurred in that year in connection with the coke ovens and blast-furnaces erected in the South Durham coalfield. "The Waste Heat and Gas Electrical Generating Stations, Limited," was formed in 1907, to promote the use of waste heat for power purposes, and this company has developed so satisfactorily that it now controls nine of the waste heat power stations running in the South Durham area. Its success is proved by the fact that it has paid 8 per cent. on its ordinary share capital for the past few years, and has accumulated a reserve fund of £70,000 to provide for future contingencies. According to R. P. Sloan, who contributed a paper on the subject to the meeting of the British Association at Newcastle last year, there were at that date eleven waste heat power stations operating in the North-East Coast area, and two of these alone turned out 40,000,000 units of electricity per annum. The problem of utilising the waste heat from iron and coke oven plants has therefore been solved satisfactorily in this district, and has led to savings which are estimated to be equivalent to 150,000 tons of fuel per annum.

The waste heat stations in the North-East Coast scheme operate in conjunction with the County of Durham Electrical Power Supply Company, and also with the Cleveland and Durham County Electrical Power Company, the area served by these two power companies extending to 1400 square miles, and the total energy supplied at present being 343,000 horse-power. The waste heat stations are placed close to the larger coke ovens and blast-furnace plants, and operate in parallel with the five main stations of the power companies. They are run at their maximum capacity, and all regulation of the power is effected by the main supply stations. The main distribution and transmission system is three-phase, and the working pressure is 20,000 volts. The power is utilised chiefly in the engineering shops and shipbuilding yards situated on the Tyne and Wear, and as the purchasing companies have a market for their current many times greater than the output of any individual waste heat station, it is possible to run these stations continuously at their full capacity, and to utilise to the best possible extent the machinery installed in them. Unfortunately for scientific purposes, no figures have been published, or can be obtained, for the thermal or working efficiency of these North-East Coast waste heat stations, and therefore it is impossible to say how the system adopted compares in practical value and economy with the waste heat stations situated in other countries. As the most notable and financially successful scheme of waste heat utilisation in the United Kingdom, however, the North-East Coast developments deserve first mention in any article on the subject.

The Blaydon and Rowlands Gill Developments.—In 1904 by-product coke ovens were erected at the coking works attached to the Priestman Collieries at Blaydon, near Newcastle, and a complete installation of water-tube boilers was added in order to utilise the waste heat of the ovens. At Blaydon there are ninety ovens, and the steam produced from the waste heat is employed to generate electricity in an up-to-date power station, which is worked in co-operation with the Newcastle Electric Supply Company's stations. At Rowlands Gill there is an installation of 200 beehive ovens, and in 1909 nine Stirling water-tube boilers were erected on the main flues which carried the waste gases from the ovens to the chimney. Two Bettington tubular boilers and four Stirling boilers, fitted with under-feed stokers, were added for the purposes of burning coke ballast—one of the waste products of the coking works—and also to provide an alternative source of steam power when the ovens were not working.

The electric power station at Rowlands Gill contains four Westinghouse turbines, coupled to three-phase alternators, generating current at 6000 volts for supply to the Newcastle Alloy Company's Works in the vicinity of the generating station. As regards the working efficiency of the Rowlands Gill boilers, the following are figures given by A. D. Pratt in a valuable and important paper read before the American Society of Mechanical Engineers—in New York—on December 16th, 1916. The test, it may be explained, was made on one of the Stirling boilers rated at 161 horse-power, and worked in connection with twenty-two beehive ovens producing coke from an average of 3800 lb. coal per hour, or 173 lb. per oven per hour.

Heating surface	1610 sq. ft.
Gas weight	23,200 lb. per hour
Gas per sq. ft. of heating surface	14.4 lb. per hour
Temperature—	
Entering boiler	1720 deg. Fah.
Leaving boiler	650 "
Drop in temperature	1070 "
Horse-power developed	187
Approximate rate of heat transfer	4.7 B.Th. units per sq. ft. per hour per degree of temperature difference
Draught (natural chimney draught)	.56in.

BELGIUM.

The famous Cockerill Company of Liége started experiments in 1909, with the object of utilising the heat contained in the waste gases from the large gas engines working with blast-furnace gases, the heat in these gases being estimated to amount to 650 calories per horse-power hour. The type of boiler the engineers of the Cockerill Company evolved for the purpose consisted of a horizontal tubular boiler surmounted by a vertical tubular economiser. The gases which left the engine with a temperature of 446 deg. Fah. entered the boiler and were reduced in the economiser to 230 deg. Fah., while the water was heated up from 46 deg. Fah. to 338 deg. Fah. The water then passed into the boiler, where it was converted into steam at a pressure of 114 lb. per square inch. Four boilers of this type had been installed by the Cockerill Company before the war broke out, and were developing 5000 horse-power. Steam was raised in the proportion of 1.93 lb. per E.H.P. developed by the gas engine, and it was estimated that the boilers recovered 55 per cent. of the heat of the waste gases, and increased the thermal efficiency of the gas engines by 13 per cent.

The late M. Greiner calculated that with four gas engines of 1500 horse-power each, the savings effected by the installation of waste heat boilers would amount to £3880 per annum. If it be accepted that a thermal efficiency of 30 per cent. can be obtained in the gas engine, then the additions of a waste heat recovery plant would raise the efficiency to 35 per cent., or to double that of the best steam plant.

GERMANY.

As customary, most of the German records of trials and tests of waste gases for steam-raising purposes are more scientific and exact in their form than those of other countries. The most important and valuable of the results for comparative purposes are those recorded by Butow and Dobblestein in the mining paper *Gluckauf*. The tests related to trials with the Wefer patented system of boiler firing—with coke oven gas—which was designed to secure a better mixture of the combustible gases and air passing into the boiler furnace, and also to minimise the risks due to back-firing, or to explosions in the mixing chamber. In the early types of burners for boilers fired with coke oven gas the gases were introduced by simple nozzles, air being supplied through openings in the furnace front. Imperfect mixing of gas and air led to imperfect combustion. In the Terbeck burner a mixture of gas and air was obtained on the principle of the Bunsen burner, and a secondary air supply was arranged at the combustion point. By the use of this burner, the steam output per ton of converted coal rose from 355.6 to 600 kilos., and the evaporation per square metre of heating surface per hour from 7.2 to 14.3 kilos. In the Wefer system, gas flows from the main into the twenty-five iron pipes feeding the graphitic burner tubes through a chamber, one end of which is formed by a hinged explosion cap. This uncovers the full section of the chamber in case of back-fire, and closes automatically when the latter has expended its force. It also affords thorough access to the burner tubes. Air is supplied through a ring valve to a separate chamber, whence it flows concentrically with the gas tube for a distance, and is thus thoroughly mixed with the gas before ignition. An eight-hour test on a double fire-flue boiler of 1280 square feet heating surface gave the following results—summarised :—

Steam pressure (gauge)	11.5 atmospheres
Steam temperature	311 deg. Cent.
Mean gas pressure	3.5in. water
Mean gas temperature	27 deg. Cent.
Mean calorific value of gas ..	461 B. Th. Units per cubic foot
Excess air supply	1.71
Evaporation from and at 100 deg. Cent.	286.5 lb. per 1000 cubic feet of gas
Evaporation per sq. ft. heating surface	4.47 lb. per hour
Thermal efficiency	71 per cent. (to saturated steam)
	8.2 per cent. (in superheat)
Total	79.2 per cent.

Forty-eight Wefer furnaces—in 1912—had been in satisfactory operation at the Victor Pit—Rauxel—for nine mouths. Assuming a boiler of 120 square metres heating surface to yield 18,000 tons of steam during 300 working days, it is shown that the costs per metric ton of steam are :—Wages, 3 pf.; maintenance and cleaning, 2 pf.; feed-water, 5 pf.; interest and depreciation, 10 pf.; total, 20 pf. per ton. This figure may be compared with the average estimate of 1.6 marks (160 pf.) per ton of steam in coal-fired installations.

Another series of trials carried out in 1914 with an improved form of Wefer burner gave the following results, the tests being carried out on a boiler with the two flame tubes (fire-tubes) fitted with the new burner :—

Heating surface	1241 sq. ft
Gas analysis—	
CO_2	1.6 per cent.
O	1.8 "
CO	4.6 "
H	52.2 "
CH_4	28.8 "
Heavy hydrocarbons	1.6 "
N	9.4 "
Mean calorific value	428 B. Th. units per cubic foot
Gas pressure	5.8in. (water) at 35 deg. Cent.; barometer, 29.7in.
Flue gases—	
CO_2	8.3 per cent.
O	3.24 "
CO	Nil
Excess air ratio	1.16
Furnace temperature	1425 deg. Cent.
Steam	12 atmospheres (gauge); 297 deg. Cent. at superheater
Steam	7219 lb. per hour
Gas	24,854 cubic feet per hour
Evaporation	291 lb. per 1000 cubic feet of gas and 5.81 lb. steam per sq. ft. heating surface per hour
Thermal efficiency to saturated steam	77.6 per cent.; including superheat, 84.6 per cent.
Loss by conduction and radiation	15.4 per cent.

Comparison with the earlier test data shows a net gain of 3.4 per cent. in the thermal efficiency, despite the increase in evaporation from 4.47 lb. per square foot to 5.81 lb.

In the improved Wefer burners used for these tests, the coke oven gases flow from the gas chamber through forty distributing tubes, and are delivered about two-thirds the distance along tunnels, in the graphite burner block. The use of forty distributing tubes in place of the twenty-five of the earlier burner secures a better mixture of the gas and air. The latter is admitted through a ring-valve, and flows concentrically with the gas tubes to the mixing chamber at the burner head. The original form of Wefer burner extended into the fire-tube of the boiler for a distance of 2ft., but the improved form is built on to a tubular extension of the furnace front, and thus the whole length of the fire-tube of the boiler is available for heat transfer.

To provide for back-firing and explosions a central tube 8in. diameter is inserted in the burner, with a simple explosion valve on its outer end. The combustion chamber is lined with fire-brick, and in order to promote more perfect combustion of the gases, a perforated plate and a bank of short tubes of fire-clay are mounted in the fire-tube of the boiler. At the Victor Pit, where these trials of the Wefer burner have been carried out, a gasometer with a capacity of 1,400,000 cubic feet has been erected in order to secure a steady pressure of gas when delivered to the burners. As the gas is now being stripped of all its benzol in a by-product recovery plant, the thermal value of the gas is not so high as it was at the time of the tests.

In comparison with the above tests of the Wefer burner, figures given by Ortmann in the August, 1913, issue of *Stahl und Eisen* for the results of tests made with blast-furnace and coke oven waste gases may be quoted. The boiler used for blast-furnace gas had 968 square feet of heating surface, and was provided with an economiser. The thermal efficiencies in three separate tests were 79.4 per cent., 76.8 per cent., and 82.7 per cent., giving a mean of 79.6 per cent. The other boiler had a heating surface of 925 square feet, and showed in two separate tests efficiencies of 74.9 per cent. and 80.2 per cent., when fired with coke oven gas, the mean in this case being 77.5 per cent. The calorific value of the gases and other details are not available in this

case, so it is impossible to say whether the burner used was as efficient as the Wefer burner.

UNITED STATES.

Although America possesses no plant or scheme so notable as that found in the South Durham coal and iron districts for the utilisation of waste heat, a large amount of practical work has been carried out, and in a paper presented at the 1916 annual meeting of the American Society of Mechanical Engineers, Mr. A. D. Pratt gives a useful review and summary of what has been achieved in connection with this problem across the Atlantic. (See *Metallurgical and Chemical Engineering*, December 15th, 1916, and January 1st, 1917.)

The design and operation of boilers for utilising the waste heat of open-hearth steel furnaces, cement kilns, copper furnaces, beehive coke ovens, and heating furnaces generally, are discussed in this interesting paper, and from it the following particulars are extracted of the waste heat installation at the plants of the H. C. Frick Coal and Coke Company, at York Run, Pa., and of the Indiana Steel Company at Gary, Ind.

At York Run fifty beehive coke ovens are connected to three Stirling boilers provided with standard type of baffles, and 3600 square feet of heating surface each. The test extended over a full week's run of 168 hours, and there were on the average forty-four ovens in service, coking coal at the rate of 13,800 lb. per hour, or 314 lb. per oven per hour. The weights of gas and temperatures varied considerably during the week, the lowest temperature noted being 1500 deg. Fah., and the highest 2075 deg. Fah. The exit temperatures varied from 475 deg. Fah. to 550 deg. Fah., and averaged 490 deg. Fah. The gas consumed in this test, expressed as lb. per hour, was 83,650, and expressed as lb. per hour per square foot of heating surface was 7.7. The drop in temperature of the gases in passing through the boilers was 1314 deg. Fah., and the horse-power developed amounted to 824, or 76 per cent. of the rated capacity of the boilers. The approximate rate of heat transfer was 3.2 B. Th. Units per square foot per hour per degree of temperature difference.

The above represents the results obtained with an early installation of boilers for utilising the waste gases from beehive ovens, and later installations in the United States of America show considerable improvement upon these results.

At a more modern plant, provided with a specially designed Babcock and Wilcox boiler, eighteen sections wide, each section made up of 26ft. by 20ft. tubes, and thus providing 10,200 square feet of heating surface, the draught is furnished by a turbine-driven induced draught fan, and a much higher rate of heat transfer is obtained, due to the greater speed at which the gases are passed through the boiler. The results of two tests with this boiler were as follows :—

	No. 1.	No. 2.
Gas consumed, pounds per hour	125,500	155,100
Gas per sq. ft. of heating surface per hour	12.2 lb.	15.2 lb.
Temperatures—		
Inlet to boilers	2329 deg. Fah.	2158 deg. Fah.
Exit from boilers	463 deg. Fah.	477 deg. Fah.
Drop in temperature	1866 deg. Fah.	1681 deg. Fah.
Power developed	1750 H.P.	1956 H.P.
Per cent. of rated capacity of boiler	172	192
Approximate rate of heat transfer*	5.6	6.8

* Expressed as B. Th. Units per sq. ft. per hour per degree of temperature difference.

The performance of this first boiler has been so satisfactory that six additional units have been ordered by the owners of this coking plant, the only difference being that there are twenty-seven sections instead of eighteen, and that each boiler possesses 15,300 square feet of heating surface, equivalent to a capacity of 9180 horse-power for the six units.

The utilisation of the waste heat from open-hearth steel furnaces has been practised for many years in America, and according to Pratt, (see paper already quoted) there are already installed or on order, boilers capable of producing 90,000 horse-power from this type of waste heat alone. These boilers are connected to 190 open-hearth furnaces which produce annually over nine million tons of steel, and experience has shown that through the use of these waste heat boilers the net cost of production is reduced by 20 to 25 cents per ton, and that a total economy of 1,840,000 dols. is earned on the above output of steel. The fear that the installation of waste heat boilers, with their fans and other accessories, would cut down the production of the open-hearth steel furnace has proved groundless, for the figures show that the improved draught resulting from the use of fans, leads to a reduction in the time of the separate heats, and increases the tonnage capacity of the furnace.

The installation of waste heat boilers at the Gary Works of the Indiana Steel Company consists of twenty-eight special six-drum Rust type of boilers, equipped with special cross baffles, in order to give the desired gas velocities over the heating surfaces. Each boiler has a heating surface of 4880 square feet, and that to which the following tests relates, developed under test 393 horse-power, or 80.6 per cent. of its rated capacity :—

Gas weight	83,434 lb. per hour
Gas per sq. ft. of heating surface	17.1 lb. per hour
Temperatures—	
Entering boiler	1155 deg. Fah.
Leaving boiler	530 ,,
Drop in temperature	626 ,,
Draught at boiler inlet	1.47in.
Draught at boiler damper	3.95in.
Loss in draught	2.48in.
Approximate rate of heat transfer	6.92 B. Th. Units per sq. ft. per hour per degree of temperature difference.

LONGITUDINAL SLEEPERS FOR RAILWAYS AND TRAMWAYS

A NEW method of constructing railway and tramway lines has been introduced by Signor Olindo Valeri, of Asti, Italy, who has courteously sent us the following particulars of the system. It consists in providing a series of interlinked sleepers of reinforced concrete, arranged lengthwise beneath either rail of the line, as shown in Fig. 3. The main feature of these longitudinal sleepers is that they are capable of a rocking motion, since they rest on a pedestal with the centre line of their base only. This rocking motion permits a certain resiliency of the rail. Interposed between the sleepers and the rails are blocks or cushions of hard wood, which form the real supports of the rails, these supports being spaced about the same distance apart as are the cross sleepers generally used.

Experiments with Signor Valeri's sleepers began some months ago on the line between Asti and Altavilla, of the Società Astese Monferrina di Tramvie e Ferrovie of Asti.

Figs. 3, 4 and 5 give details of the new construction, while Fig. 2 shows a piece of line, laid on this principle, before the ballast has been applied. In the drawings R, R indicate the rail, C, C the ferro-concrete sleeper, Q is the wooden block or cushion interposed between sleeper and rail, G a bolt for anchoring the rail to the sleeper, L the link between successive sleepers, and B, B the base or pedestal for each sleeper. The rails are held to gauge by means of a number of tie-rods T, of which, as a rule, one is provided for each couple of oppositely arranged sleepers. These gauge bars engage the rail by aid of clamps, which grip the base of the rail, so that it is not necessary to drill the rails.

Two sleepers constructed in accordance with the new system proposed by the writer were submitted, after almost four months' seasoning, to a hydraulic pressure test at the Laboratory of the Turin Technical

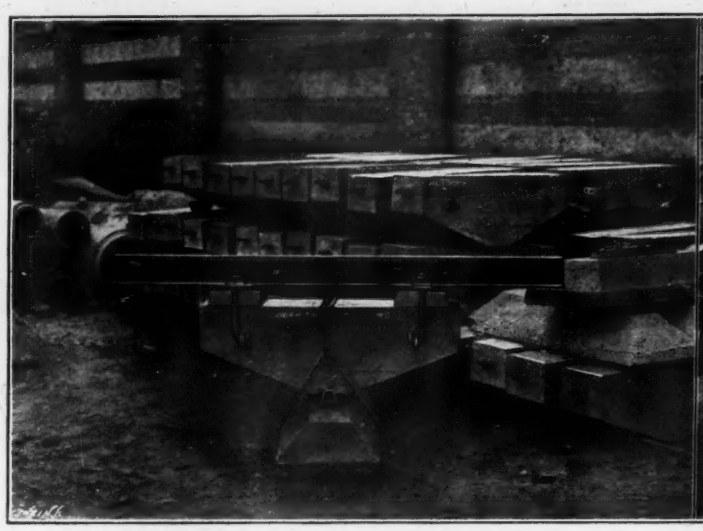


Fig. 1—CONCRETE LONGITUDINAL SLEEPERS

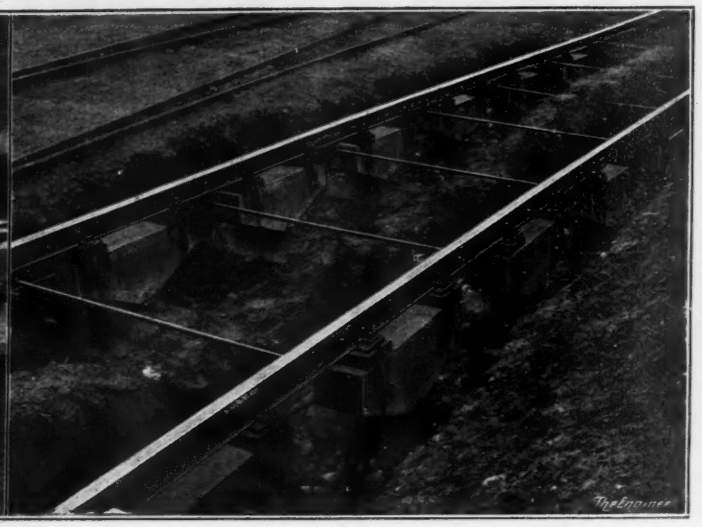


Fig. 2—LINE LAID WITH VALERI SLEEPERS

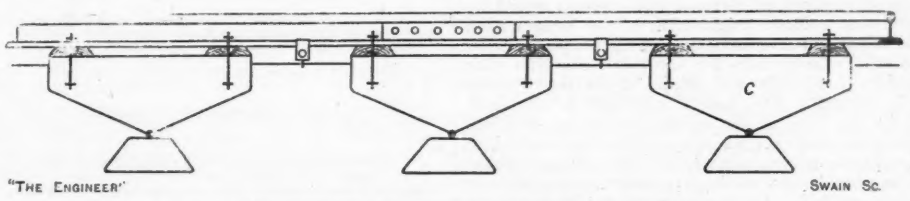


Fig. 3—ARRANGEMENT OF CONCRETE LONGITUDINAL SLEEPERS

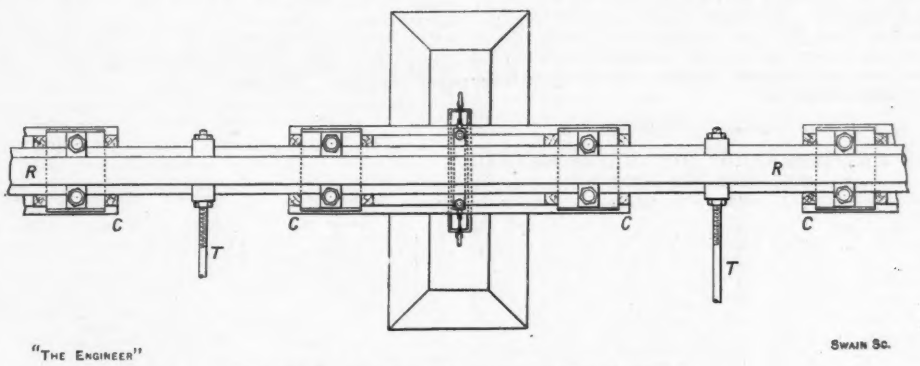


Fig. 4—PLAN OF LINE LAID WITH VALERI SLEEPERS

High School. The first fissures could be observed when the pressure had reached about 12,000 kilos., and the sleeper broke under a pressure of 18,000 kilos., viz., under a pressure of about 9000 kilos., nearly 9 tons, on each of the two supports.

Signor Olindo Valeri points out, in connection with this test, that a sleeper which is submitted by itself to the action of a hydraulic press, is in a much more unfavourable position than a sleeper actually in service and forming part of a line of railway. A line of rails, and particularly such rigid rails as are those of large weight per unit of length, forms a continuous beam laid on an indefinite number of supports, and partly fastened, or at least not completely free, to move.

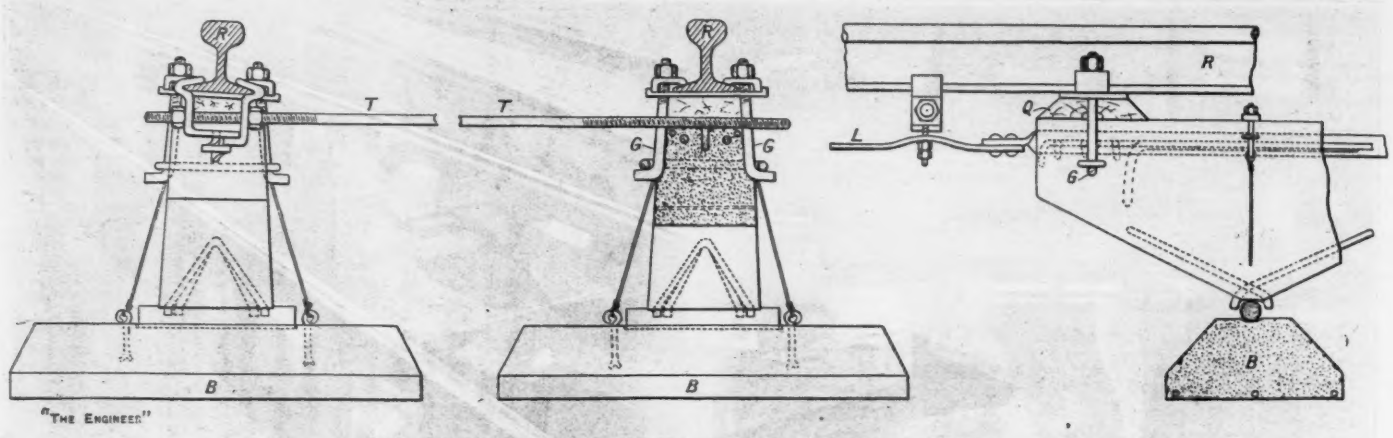


FIG. 5—DETAILS OF RAILWAY WITH LONGITUDINAL CONCRETE SLEEPERS

Moreover, the sleeper reacts against dynamic shocks, both by reason of its ability to swing, and the links between the successive sleepers, as well through the natural reaction of the ground, and he assumes that the utmost stress which a sleeper has to resist when a train is passing over the line is more or less equal to the normal load on a wheel, which, on the line where these sleepers are being tested, is about 7 tons. The pressure will have its maximum value when the wheel bears on the rail at the point which corresponds to the centre of the sleeper, when each of the supports will bear a weight of 3.5 tons. As has been said, the sleeper broke under a pressure of about 9 tons on each support, which ought to provide a wide margin of safety. In many cases the quantity of additional material required to increase that margin would be small, since a slight heightening of the sleeper with concrete only will be sufficient for the purpose.

Another claim made for the system is that it is possible, not only to obtain a perfectly level track, but, as a rule, also to maintain it unaltered. Should the level of the track have to be rectified, neither the chair nor the sleeper need be removed, as the requisite adjustment may be obtained by suitably altering the height of the wooden cushions between sleeper and rail. The rail is prevented from canting by the bolts employed for anchoring the rail to the sleepers, also by the action of the tie rods, and because they are connected to the two ends of the neighbouring sleepers.

Briefly, the objects which were kept in view when the system was evolved, were to attain (*a*) uniform elasticity; (*b*) a greater perfection in, and a greater maintenance of, the level of the line; (*c*) a greater exactness and a better maintenance of the gauge; (*d*) a resistance to canting at least equal to that possessed by lines as at present constructed; and (*e*) less creeping of the rails. The material required for the construction with the new longitudinal sleepers of one metre track for a big railway consists of about 0.125 cubic metres of ordinary ballast, and about 47 kilos. of reinforcement.

THE DETERIORATION OF CURTIS RATEAU TURBINE BLADING.*

By A. FENWICK, Member.

THE object of this paper is to place on record the behaviour of certain materials used in turbine blading. The information and data given below summarises the experience gained during the past six years in operating and maintaining the turbine plant of the Rand Power Companies—V.F. and T.P. Co., Limited, and R.M.P.S. Co., Limited. Table I. gives particulars of the plant dealt with. Table II. shows the metals in present use on the various turbines. Some of these metals have been in use for a few months only, and are, therefore, in the experimental stage. Tables III. and IV. give the analyses of steels and non-ferrous alloys in use. Table V. shows the materials in use for wheel blading.

WHEEL BLADING.

An examination of these machines shows a variation of some thousands of running hours in the "life" of blades of similar material and position in the turbine, and the "life" here represents the running period up to the time re-blading was carried out. In some cases the blades could safely have been run for a longer period, but owing, perhaps, to a complete dismantling of the set or extensive repairs to later stages, it has been advisable to re-blade. In other cases, owing to difficulties in taking the set out of commission, blades have run much longer than they should have done, considering the safety of the machine. It will be noticed that in some cases, where the wheel and guide blading have not been renewed, the running hours differ for the same turbine. This is explained by the fact that the complete turbo drum was removed for repairs, a spare drum taking its place.

3000-*kilowatt Turbines, Class* 1.—Dealing first with the Curtis stage, and the first three low-pressure stages, two materials have been tried, viz., aluminium bronze (L) and 5 per cent. nickel steel (P), and the superiority of the latter is apparent. No particular trouble has been experienced from corrosion of the steel, although if the machine is standing for any length of time the blades become rusty, which, however, soon wears off with use. Sets 5 and 6, Simmer Pan, were fitted with steel blades, and have been running for six years. In neither case has failure occurred, the running hours up to December 31st, 1916, being 39,119 and 39,298 respectively.

The aluminium bronze blades have a very different record, and are quite unsuitable for this part of the turbine. The aluminium content disappears from the surface of the metal, leaving a very brittle layer of copper. Where the section of metal is thin, as at the inlet and discharge edge of the blades, it breaks away like glass with light tapping. With continued use, the outer layer cracks and flakes off, exposing the part underneath, which in turn flakes off until the blade is split up into several layers. Where the section of the blade is fairly heavy, as in the Curtis stage, the shape is gradually lost, but the body of the blade remains sound and seldom fails. What usually happens is, the portion which is riveted over to secure the shrouding chips off, allowing the latter to come adrift. Fig. 1 (Specimen 6/13) is a good example of this deterioration, and is from the first row of Curtis moving blades, after being in commission for about 24,000 hours. The flaking of the metal referred to is very much in evidence, and the rivet heads in this sample are particularly bad, having practically disappeared. Fig. 2 (Specimen 7/13) is from the second row of Curtis blades on the same machine. The deterioration is similar, but not so far advanced. The running hours are the same.

The running time before re-blading was carried out varied considerably, but an average has been taken for the first four stages on sets 1–4, Simmer Pan, and works out at 26,700 hours.

The Curtis blades have a shorter life than the later stages, and this is no doubt due to the higher temperature in the Curtis casing. After leaving stage 4 the deterioration takes a different form, erosion or pitting of the back or convex portion of the blade being usual. The inlet and discharge edges of the blades also become very thin and holed, and are easily broken off. Fig. 3 (Specimens 13, 10, 11, 12/13) shows some typical examples. The blades are from stages 5, 6, 7 and 8 respectively, on No. 5 set, Simmer Pan, and in this case ran for 33,665 hours before being renewed. While a certain amount of erosion has taken place, due to minute particles of matter passing through with the steam, and a certain amount of moisture in the latter, the pitting looks as though chemical action had taken place, and may be due to certain impurities in the steam becoming active in the presence of moisture. It is curious that the action should be confined to these stages, as the two following stages (9 and 10), also of aluminium bronze, do not suffer. The four examples here shown would undoubtedly have lasted several thousands of hours longer before actual failure occurred. It was thought possible, however, that the roughness of the blades would detract from the efficiency of the set. After re-blading, careful tests showed that no appreciable improvement had been made in steam consumption. The last two stages stand up well, the present running hours varying from 39,000 to 46,500 on the first four sets at Simmer Pan, and up to 52,000 on one of the two sets at Brakpan, which in each case is the total running time of the machine. In no case have these stages had to be renewed owing to deterioration, although the edges are naturally worn somewhat, and in many cases have suffered mechanical damage by fouling broken pieces of guide blading, and had to be re-straightened.

Our present practice is to fit the first four stages with 5 per cent. nickel steel blades, stages 5 to 8 with brass blades, and the last two stages with aluminium bronze. Brass has not been in commission long enough on these particular sets to show whether it will prove more satisfactory than the bronze, though, judging by experience obtained on other types of machines, it is highly probable. It may also be found that brass would do equally as well as bronze in the last two stages, and, personally, the author is of opinion that 5 per cent. nickel steel for the first eight stages and aluminium bronze for the last two would prove very durable and give good results.

9600-*kilowatt Turbines, Class* 2.—The blading has, with two exceptions, proved satisfactory up to the present, and Table V., giving particulars of wheel blading, shows the material originally used. The maximum running hours for the set which has been longest in commission are 30,673 to December 31st, 1916, with the exception of row 3, Curtis stage, the running hours of which vary from 15,000 to 23,490. The other turbines under this class have at present run less than 30,000 hours, the time varying with the dates of installation. With the exception of row 3, Curtis stage, and stage 13, referred to later, none of the blading has been renewed unless damaged mechanically, and shows no visible deterioration of the metal. On the first row of Curtis blades the entrance edge is worn slightly concave, not sufficient, however, to warrant renewal. On the non-ferrous stages the deposit which collects under the blade shrouding has been found to contain copper, showing that a certain amount of erosion

TABLE I.—*Particulars of Turbines Installed.*

Class.	Output.	Installed at.	Date.	No. of sets.	Steam pressure stop valve. Poundsper sq. in.	Steam temperature stop valve. deg. Cent.	Steam temperature Curtis casing. deg. Cent.	Temperature vacuum. deg. Cent.	Revolutions per min.	Mean blade velocity. Feet per sec.
1	3000-kilowatt generator turbines.	Simmer Pan.	1909–10	6	200	300–310	220	35–40	1500	Curtis 466
		Brakpan.	1908–9	2	190	280–290	200	40–45	1500	Rateau 410
2	9600-kilowatt generator turbines.	Rosherville.	1911	5	220	320	240–250	40–45	1000	325 to
		Vereeniging.	1912	4	220	350	250–260	40–45	1000	350
3	4000 horse-power compressor turbines.	Rosherville.	1911 1913	6	220	320	220	35–40	3000	Curtis 515 Rateau 645
4	12,000-kilowatt generator turbines.	Simmer Pan.	1914	2	220	350	250–260	35–45	1500	Curtis 516 St. 2 to 11
		Brakpan.	1914–15	2	220	350	250–260	35–45	1500	456 to 392 St. 12 582
5	10,000 horse-power compressor turbines.	Rosherville.	1914	3	220	330	220	35–40	3000	Curtis 618 Rateau 721
6	300 horse-power auxiliary turbines.	Rosherville.	1911	11	220	320	245	—	1400	Curtis 200
		Vereeniging.	1912	4	220	350	255	—	1400	
7	550 horse-power circulating pump turbines.	Vereeniging.	1912	4	220	350	250	—	1040	Curtis 230
		Simmer Pan.	1914	2	220	350	250	—	1040	

TABLE II.—*Showing Various Metals in use for Blading.*

Mark	Material.	Class of turbine.	Wheel or guide blades.
A	4 p.c. nickel steel.	2 and 3.	Guide.
B	Siemens-Martin steel.	2, 3, 4 and 5	,,
C	5 p.c. nickel steel.	2, 3, 4 and 5	,,
A1	3 p.c. nickel steel.	3	,,
H	Medium carbon steel.	2, 4 and 5	,,
J	30 p.c. to 32 p.c. nickel steel.	1, 2, 3, 4 and 5.	,,
K	25 p.c. nickel steel.	3	Wheel and Curtis segment.
P	5 p.c. nickel steel	All classes.	Wheel and Curtis stationary segment.
L	Aluminium bronze.	1, 2, 3, 4, 5 and 6.	Wheel and Curtis stationary segment.
M	Brass.	All classes.	Wheel and Curtis stationary segment.
N	Nickel brass.	3	Wheel.
O	Monel metal.	3	Wheel and Curtis stationary segment.

* Paper read before the South African Institution of Engineers. Abridged.

has occurred. This, however, is not visible on the blades themselves.

On row 3 (Curtis) the aluminium bronze proved distinctly unsatisfactory, and became so brittle that in some cases the blades broke away from the wheel, and in all cases the edges were so brittle within the running hours above mentioned that pieces could be knocked out with a slight tap. The bronze in this row has since been changed for steel, with satisfactory results. On sets 3 and 4, Vereeniging, steel was used from the first, and has run 25,000 hours, being at present in excellent condition.

Fig. 4 (Specimens 5, 6/15) shows good examples of aluminium bronze blades from row 3 (Curtis) from two different turbines. The blades were renewed after 15,000 and 18,000 hours respectively.

The brass blades in stages 6 to 9 are in excellent condition from a deterioration point of view, but in several cases have been severely damaged mechanically from various causes, and successfully straightened up.

at the Government laboratory on a new blade, and on one of the broken ones, showing the new material to stand 44.9 tons and the old 29.8 tons per square inch before fracture. It would seem, therefore, that the material has lost a good deal of its original strength, although there is very little difference in outward appearance. In some cases the blades have fractured about 1¼in. above the rim of the wheel, *i.e.*, just above the distance piece. Some of these blades (stage 13) have run from 20,000 to 30,000 hours, and are still sound. Breakage occurred in three cases after 24,900 hours, 23,800 hours, and 10,600 hours respectively.

It should be noted that erosion of the inlet edge of the blades in the later stages, due to wet steam, is almost invariably absent on the turbines just described. One or two isolated cases are on record, but are very slight.

4000 *Horse-power Compressor Turbines, Class* 3.—It will be noticed that 25 per cent. nickel steel has been used for row 1 of the Curtis stage. This, however, is an isolated case, as far as the author is aware, for moving blades on these turbines, although this material is in use for Curtis stationary blading. A peculiarity of this steel is its non-magnetic property. In this particular case failure occurred after running for 17,700 hours, although in outward appearance the metal appears to be quite good. An examination of the turbine after breakdown occurred showed the inlet nozzles to be intact, and although it is possible that some foreign matter may have passed through the nozzles and fouled the blades, it is improbable, and it may be concluded that these particular blades broke owing to brittleness of the metal acquired by use with high-temperature steam and vibration.

Five per cent. nickel steel in use on the other sets for row 1 has given satisfaction up to the present, but the running hours to date are much less than the generator turbines previously referred to, 15,600 hours being the maximum. In the second row of Curtis blades, two materials have also been tried, namely, A1 bronze (L) and 5 per cent. nickel steel (P). The former proved quite unsuitable in all cases, and has now been replaced by 5 per cent. nickel steel. The 5 per cent. nickel steel now in use for row 2 has so far proved satisfactory, but has only been tested for 11,500 running hours.

Fig. 1

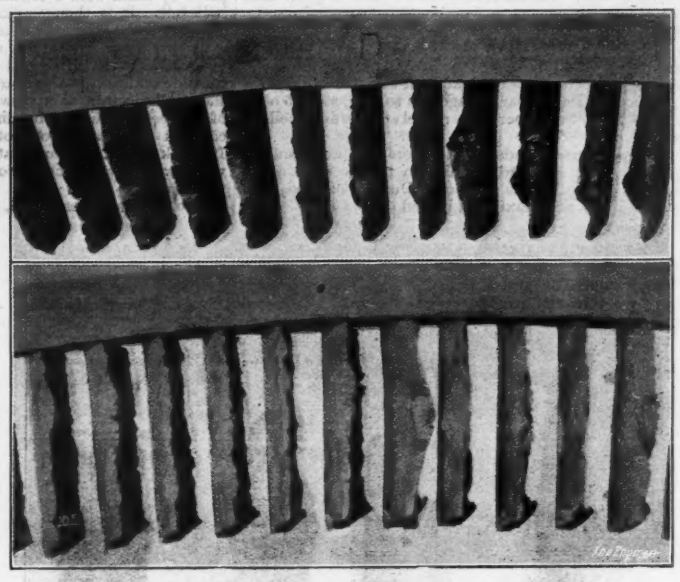


Fig. 2

The aluminium bronze blades in stages 2, 3 and 4 have a similar record to those referred to above, and Fig. 5 (Specimens 1/11 and 3/11) shows good examples from the second and fourth stages respectively after 10,500 running hours. They certainly look as though the inside of the turbine was no place for them, although, judging by the quality of the metal in the heavy part of the blade, there is no doubt they would continue to do their work inefficiently for quite a long time. These three stages have now been replaced by brass, and although sufficient time has not elapsed to say that this material applied to these stages is satisfactory, examination after 11,000 hours does not show any deterioration, and it will certainly prove to be much more suitable than the aluminium bronze. The metal is quite soft and pliable, and the thin edges stand up remarkably well to the steam temperature.

In stage 5 aluminium bronze is again used, and also stands well. In no case has this stage been renewed owing to deterioration, the maximum running hours being 18,000 odd. The temperature is fairly low at this part of the machine, and this doubtless accounts for the longer life. Although corrosion of the metal has not occurred, a good deal of wear has taken place, the edges of the blades being now very thin and fragile. This, however, is fair wear and tear, and cannot be avoided unless a much harder material is used.

Aluminium bronze was also tried in the sixth stage, but was unsuitable for mechanical reasons. After being in use from 5000 to 7000 hours, the blades broke near the root just above the distance pieces, and it is extremely probable that vibration was the cause. Five per cent. nickel steel was then tried, but fractured in the same manner. Ultimately a 5 per cent. nickel steel blade was used, with a reinforced root, which gave somewhat better results. The latter blades are, however, not free from breakage, and a material is required which is not so easily affected by vibration. "Monel" metal is also being given a trial, but has not run long enough to form an opinion as to its merits. Nickel brass (N) is also being experimented with for stage 5. This alloy has less tensile strength than aluminium bronze, being in the neighbourhood of 37 tons per square inch. It may, however, possess other valuable properties which will render it useful for turbine work. The steel blades for stage 6, just referred to, show a small amount of erosion on the inlet edge of the blades after 6000 hours.

Turbines, Classes 4 *and* 5.—These turbines have not been in commission for more than two years. The information, therefore, covers a much shorter period than on those previously described. Three metals are in use, 5 per cent. nickel steel, brass, and bronze, arranged in the order given, starting from the high-pressure end of the turbine. Steel is also used for the last three wheels in one case, and for the last two wheels in the other case, at the exhaust end. The metals appear to be in the correct position for the best results, and up to the present no trouble has been experienced.

One point should, however, be mentioned. Erosion of the inlet edge of the steel blades at the exhaust end of the machine is noticeable in all cases after 5000 to 6000 running hours. In the case of the compressor turbines (Class 5), running at 3000 revolutions per minute, with a blade velocity of 720ft. per second, the erosion is very pronounced, the edge of the blade being like a fine saw.

TABLE III.—*Analyses of Steels in use.*

Mark.	C. Per cent.	P. Per cent.	S.	Si.	Mn.	Ni.	W. (Tungsten).	Cr. (Chromium).	Fe.	Remarks.
A	.200	.026	.022	.198	.767	3.980	.128	.108	94.571	For guide blading only. Experimental stage.
B	.400	.058	.050	.035	.936	—	—	—	98.521	" " "
C	.236	.056	.030	.120	.648	4.860	—	—	94.000	" " "
A1	.273	.045	.028	.046	.612	3.170	—	—	95.826	" " "
H	.350	.030	.040	.200	.5	—	—	—	98.880	Guide blading only. Considerable pitting in some cases
J	.310	.036	.046	.350	.540	30.650	—	—	68.068	Very unsatisfactory. Cracks badly
K	—	—	—	—	—	25 p.c.	—	—	—	Analysed for nickel only. Unsatisfactory. Used for wheels and Curtis stationary segments.
P	.204	.016	.010	.046	.288	4.750	.350	—	94.336	For wheel blading only.

TABLE IV.—*Analysis of Non-ferrous Alloys in use. Used for Wheel Blading only.*

Mark.	Cu.	Al.	Fe.	Zn.	Pb.	Ni.	Tensile strength of, tons per sq. in.	Specific gravity.	Remarks.
L	89.00	8.5	2.5	—	—	—	44 actual blade.	7.73	Aluminium bronze. Very unsatisfactory in high temperature stages.
M	72.50	—	.01	27.48	Trace.	—		8.58	Brass. Stands well.
N	50.0	—	.6	39.4	—	10	37 actual blade.	8.43	Nickel brass. Experimental
O	30.00	—	1.50	—	—	68.50	Approx. 40 rolled bar.	—	Monel metal. Experimental.

The aluminium bronze blades in stages 10, 11, and 12 have proved satisfactory, but in stage 13 breakages of the blades have occurred. The blades are secure to the wheel by a tee-headed root, and fracture frequently occurs across the neck of the tee. The weight of the complete blade is 9 oz., and the mean velocity 327ft. per second, at a radius of 3.1ft. The stress is, therefore, not excessive, being 601 lb., which, taken over an area of .1 square inch = approximately 3 tons per square inch. It is very probable that vibration of the blade is largely responsible for the failure. A tensile test was carried out

TABLE V.—*Materials used for Wheel Blading of all Turbines.*

Class of turbine.	Curtis stage. Row. 1. 2. 3. 4.	Rateau stages. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13.	Remarks.
1.—3000-kilowatt	L. L. — —	L. L. L. L. L. L. L. L. L. — — —	On Sets 5 and 6 Simmer Pan St. 1 to 4 are bladed with "P." steel.
2.—9600-kilowatt	P. P. L.	P. P. P. P. M. M. M. M. L. L. L. L. Practically no deterioration on these stages. Maximum running hours, 30,673.	St. 2 is not fitted on Sets 3 and 4, Vereeniging, which are rated at 12,000 kilowatts. These two sets are bladed with "P." steel for the third row Curtis stage.
3.—4000 horse-power	P.* L. — —	L. L. L. L. L.† — — — — — — —	* One set only was fitted with "K." steel on Row 1. † "L." bronze now replaced with "P." steel on all sets for Stage 6.
4.—12,000-kilowatt Simmer Pan	P. P. — —	P. M. M. M. M. M. L. L. P. P. P. —	NOTE.—"P." steel is used for Stages 3 and 4in. Brakpan sets, and "M." brass for same stages in Simmer Pan sets.
Brakpan	P. P. — —	P. P. P. M. M. M. L. L. P. P. P. —	
5.—10,000 horse-power	P. P. — —	M. M. L. P.* — — — — — — — —	† There are two wheels in parallel for Stage 5, both bladed with "P." steel.
6.—300 horse-power Rosherville	P. P. L. L.		
Vereeniging	P. P. M. M.		
7.—550 horse-power Vereeniging	P. M. M. M.		

"P." = 5 per cent. nickel steel. "L." = aluminium bronze. "M." = Brass.

GENERAL.

From the foregoing remarks it is perfectly clear that aluminium bronze for use as a blade material in the high temperature stages of a turbine is totally unsuitable. It cannot be wholly condemned, however, as excellent results have been obtained when used in the low-temperature stages, and while brass might do as well

in this position, one would not expect as long a life from brass, owing to the soft nature of the material, the bronze being much harder and naturally more able to stand up to fair wear and tear. The aluminium bronze in use is, as far as we are aware, of uniform composition.

Five per cent. nickel steel has so far given good service where used, and, as previously mentioned, in some of the later turbines has been put into the last two wheels at the exhaust end. Examination shows that a good deal of wet steam or water erosion is taking place in some cases, particularly on the steam inlet edge of the blade.

As our experience does not extend beyond 10,000 hours on these new sets, we are somewhat in the dark as to the future behaviour of the steel blades in these low-temperature stages; but for the early stages up to, say, stage 5 or 6, there is no doubt that 5 per cent. nickel steel is an excellent material.

The brass in use stands the temperature well, and in several cases has replaced aluminium bronze with satisfactory results up to the present. Our experience with brass blades covers a maximum period of just over 30,000 running hours, and in no case so far has renewal been necessary owing to deterioration. It is possible that this material will outlast the steel, as a certain amount of oxidation of the latter is bound to occur.

(To be continued.)

Figs. 3 and 4

Fig. 5

CEMENT JOINTS FOR CAST IRON WATER MAINS.

A PAPER on cement joints for cast iron water mains was down to be read on Wednesday, April 18th, before the American Society of Civil Engineers, by Mr. Clark H. Shaw, Assoc. M. Am. Soc. C.E. From it we have extracted the following:—

About 1886 a cast iron pipe line for water distribution was laid with cement joints at Redlands, Cal., and in 1891 joints of that kind were used at Los Angeles, Cal., but evidently with questionable results, as the method was not adopted. In January, 1907, Mr. Charles Thornburg, then superintendent of one of the water companies operating in Long Beach, Cal., decided to try cement joints for a 16in. cast iron pumping main, and instructed his foreman of construction, Mr. F. M. Shrode, to conduct some experiments.

No definite process was outlined to the foreman, but his experiments and practice in repairing steel riveted water mains, under pressure, by using a dry mixture of neat cement in caulking the bands around these pipes, gave him an idea that a moist cement could be caulked into the bell solidly, and would produce the results desired. It was probably Mr. Shrode, who, by this experiment, finally perfected the joint and used it in the construction of the entire line. When this line was completed and put into service, working under a static head of about 190ft., several places showed some seepage, particularly at the lower end of the line, where the work was started, and it was decided to re-caulk these joints at the first opportunity; it was noticed, however, that the moisture was gradually drying up, and the seepage finally ceased.

Cast iron construction was then abandoned by the company until 1911. During that year the works came into the possession of the municipality, and Mr. Shaw was appointed Engineer of the Water Department. After looking into the merits of the cement joint, as used on this 16in. pumping main, it was adopted as the proper method of construction, and since that time it has been used throughout the entire system.

Long Beach now has sixty miles of cast iron water mains, ranging from 4in. to 24in. in diameter, laid with joints of this type. All these pipes are under pressures ranging from 40 lb. to 80 lb. per square inch, and are giving perfect satisfaction.

In making the cement joint the pipe is placed and spaced in the usual manner. A thin backing of the best dry jute is used instead of oakum, as the jute is free from oils and grease, which should be avoided. A Portland cement, conforming to the specifications advocated by the American Society for Testing Materials, is used. The dry cement is placed on a piece of canvas, usually a cement sack ripped open, and moistened with just so much water that when thoroughly mixed by hand the mixture will be of such a consistency that when gripped tight it will hold the form of the hand, and when dropped 12in. it will crumble. The canvas containing the cement is placed under the bell, and the cement is tamped into place by hand with a caulking iron until the bell is about half full. It is then caulked with heavy blows until the cement is thoroughly packed in the back of the socket. This process is continued until the bell is packed solid out to the face. A small beading of neat cement in a plastic condition is then put round the whole joint, using the caulking iron as a trowel. As soon as the initial set of the cement in the beading has taken place, the joint is covered with earth to protect it from the air and sun. In back-filling, the excavated material is always settled with water, which helps to cure the exposed portion of the joint.

The beading is essential, in Mr. Shaw's opinion, as the cement packed in the bell is so dry that, without protection, it would absorb moisture from the water used in settling the trench, and he believes that, should the joint develop seepage when the pressure is put on in the main, the cement, being dry, would expand and aid materially in keeping the joint tight.

Experiments on cement joints constructed without the beading showed that 24 hours after completion they absorbed water readily. In cases where seepage has developed and has subsequently closed, it is assumed that the dry cement absorbed the moisture from the inside, expanded, and filled the seepage pores.

About 20 per cent. of the cement is wasted by falling off the canvas or being thrown out by the caulker. If any dust or earth from the trench falls on the canvas or in the cement, it is immediately taken out, together with enough cement to make sure that the remainder is clean. In mixing the cement with water, care is taken that there shall be no lumps in the material, no matter how small. If any cement is left on the canvas when the joint is completed, it is used on the next joint, provided the work is continuous, otherwise new batches are made. Special blunt caulking tools are used.

The joint is allowed to stand forty-eight hours before the pressure is turned on and the main is put into regular service. Cement joints have been used with satisfactory results, however, twelve hours after completion, but this is not considered safe practice. Pressure tests are never made by Mr. Shaw prior to putting a main into service.

At San Diego, Cal., a pressure test was made by caulking a 6in. cast iron tee, one side of the tee being filled with a plug and each of the two ends filled with short lengths of cast iron pipe with plugs caulked in the ends. As the pieces of pipe caulked in the tee were scrap ends cut from other pipes, they had no bead on the joint end, and, notwithstanding the fact that the joint was made with smooth pipe, it took a pressure of more than 300 lb. per square inch to force the pipe out. The test was made about forty-eight hours after the joint was made.

In another test, made at Winnipeg, Man., three lengths of 6in. pipe were laid with four cement joints, on January 13th, 1916. After six days pressure was put on the pipe in increments of 25 lb., and the joints were found to show no leakage or moisture up to 125 lb. At 150 lb. one joint showed moisture on the surface of the cement.

On January 24th another test was made, and at one joint moisture appeared at 175 lb. On January 31st this joint showed moisture with 200 lb., and also on March 15th, with a pressure of 255 lb. This joint was the weakest of the four. The pressure was kept on the pipe about one-half hour in each case.

The strength and rigidity of the cement joint are shown by the following instances where cast iron mains have been subjected to severe tests: A new trenching machine was being tested by a sewer contractor in Long Beach, Cal. It operated parallel with and 5ft. from a 6in. cast iron water main, with cement joints, which had been laid in January, 1915. The trench dug by this machine was 3ft. wide and 18ft. deep. Some time before noon on February 1st, 1915, the side of the trench next to the water main caved in, leaving about 40ft. of the pipe hanging and supporting about 2½ft. of earth on top of it. This condition was not reported until the next morning, and at nine o'clock braces were put in to support the pipe. The main was under a pressure of about 65 lb. per square inch at the time. There was not the slightest seepage from any of the joints as result of this strain.

Again, in June, 1915, 94ft. of 4in. cast iron pipe with cement joints fell into a sewer trench, as the result of a cave-in under conditions similar to those just described. This pipe was under a pressure of about 55 lb. per square inch. At one end it broke at a service connection; at the other end it broke near the spigot end of a pipe, about 8in. from the joint, letting the whole 94ft. section fall into the trench. In this case every cement joint remained intact. This line had been laid in March, 1913.

Several thousand feet of 8in. and 10in. cast iron water mains with cement joints have been laid in made ground, the filling-in material being silt from the dredging of harbour channels; also several thousand feet of 8in. cast iron pipe have been laid in fine beach sand; all are giving perfect satisfaction. An 8in. cast iron main with cement joints was laid in filled ground—the soil being clay—with only 6in. of covering above the pipe when the line was put in service; the fill was then completed to 18in. above the top of the pipe, and was rolled with a 14-ton steam road roller, without causing the slightest seepage in any of the joints. The rolling was done preparatory to paving the street in which the pipe was laid. This was a very severe test of the merits of the cement joint. At the time this rolling was done, had any seepage developed, it would have been readily detected, as the whole line was within 3ft. of the edge of the fill. The fill was completed to a width of 80ft., three months later, leaving the pipe 12ft. from the centre of the street.

In several instances a cast iron main laid with cement joints has settled 3in., or probably more, in loose or filled ground, without developing any leakage. In fact, Mr. Shaw has only experienced one case in which the cement joint was not satisfactory. That was in a 6in. cast iron main in a dock, about 3ft. from a railway line. Many joints in that pipe developed seepage, and some had small pin leaks, but the leakage was not considered serious enough to warrant closing down the line for re-construction. This failure may be due, Mr. Shaw considers, to faulty construction, as the pipe was laid when the making of cement joints was in its infancy.

BOOKS RECEIVED.

What Germany is Fighting For. By Sir Charles Waldstein. Longmans, Green and Co. 1s. 6d. net

The Elements of Graphic Statics. By Ernest H. Sprague. London: Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 4. 1917. 4s. net.

How to Make Railways Pay for the War. By Roy Horniman. London: Geo. Routledge and Sons, Limited. Broadway House, 68–74, Carter-lane, E.C. 1916. 10s. 6d. net.

Industrial and Manufacturing Chemistry, Part II. Inorganic. Volume II. By Geoffrey Martin. Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. 4. 25s. net.

Mechanical Handling of Material and its National Importance During and After the War. By George Frederick Zimmer, A.M. Inst. C.E. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. 4. 10s. 6d. net.

Canada: Department of Mines—Mines Branch—Annual Report on the Mineral Production of Canada during the Calendar Year 1915, by John McLeish, No. 426; "Report on the Building and Ornamental Stones of Canada," Volume IV. Provinces of Manitoba, Saskatchewan and Alberta, by Dr. Wm. A. Parks, No. 388; Bulletin No. 14, "The Coal Fields and Coal Industry of Eastern Canada," by Francis W. Gray, No. 430. Ottawa: Government Printing Bureau, 1917.

RAILWAY MATTERS.

A LAW has just been passed in South Carolina making it an offence to use as an advertisement the sign employed by railways at a highway crossing.

THE South African Government Railway Administration has ordered twenty superheater mountain type locomotives from the American Locomotive Company.

THE Parsik tunnel, near Kalyan, on the Great Indian Peninsula Railway, has now been opened, and allows for the completion of the four lines of way between Byculla and Kalyan.

OF the 10,050 wagons and brakes in the possession of the Western Australian Railways at the end of June, 1916, 6847 were fitted with the vacuum brake, 3148 were "piped" for the brake, leaving only 55 not fitted.

DURING the five years 1912-1916 the servants of the Chicago and North-Western Railway made 25,183 recommendations on the "safety first" post-cards, supplied to them by the company, of which all but 1019 were adopted and put into effect.

IT is understood that the basis of a settlement of the dispute which led to the strike of engineers connected with the different railways having their termini in Dublin has been arrived at. The men will receive an increase of 2s. a week in their war bonus, to run from December last, thus bringing their wages up to 49s. per week.

THE Canadian Board of Railway Commissioners has issued a judgment in favour of the application of the Canadian Pacific to be allowed to build a double-deck bridge over the Summerhill Avenue ravine at Toronto. The application was opposed by the City and the Guild of Civic Art on the grounds that it would spoil the beauties of the ravine.

MAILS from Australia report that the Commonwealth Railway Department officials are hopeful that the East-West Trans-continental railway will be completed next month—August—and that the line will be opened shortly afterwards. On the eastern section some heavy cuttings are being met with and on both sections rails are being waited for.

IT is stated that a further agreement between the Railway Executive Committee and the shop-men has been arrived at, which provides for a full week's war bonus being paid to those men who, although not working on every day of the week, have made a full week's number of hours, and that men who work on Sundays are to be paid, like the men in the conciliation scheme, 10d. extra.

ON page 335 of our issue of April 13th, reference was made to certain rumours in South Wales as to closer arrangements being possible between the Cardiff and Rhymney Railways, under which Mr. E. A. Prosser, the general manager of the latter company, was to be appointed to be manager of both companies. This selection subsequently was realised, and now it is stated that Mr. Prosser is also to succeed Mr. Beasley, the general manager of the Taff Vale Railway.

STATISTICS tabulated by the Inter-State Commerce Commission show that the average freight trainload of 1916 was 17.75 tons, an increase of 9.99 per cent. over the average of 1915, and of 54.54 per cent. over 1910. Although the number of tons of freight carried one mile increased 20.55 per cent. over 1915, and 39.77 per cent. over 1910, there was an increase in the number of miles run by freight locomotives of only 13.7 per cent. as compared with 1915, and of only 5.44 per cent. as compared with 1910.

IN connection with the recent celebration of the jubilee of the establishment of the Canadian Dominion, it is of interest to note that in order to get the Maritime Provinces to come into the federation it was agreed at an inter-provincial conference, held in Quebec, in October, 1864, that the general government should secure, without delay, the completion of the Intercolonial Railway from River du Loup, through New Brunswick, to Truro, in Nova Scotia. The Intercolonial has never been a financial success, but this must be set off against the political advantages that were gained by the Maritime Provinces coming into the scheme for the establishment of the Dominion. Later—in 1871—British Columbia agreed to join provided that that province was linked up by railway to Eastern Canada.

THE terms of reference as to the appointment of Mr. T. R. Johnson to inquire into the working of the Victorian railways are as follows:—He is appointed a commission into the working, as a business undertaking, of the Victorian railways, more especially in relation to the prevailing rates, charges, methods, practices and policies existing, adopted, or favoured, by those concerned or connected with the management of such railways, with a view to ascertaining, and how far, such matters or some, or any, of them is, or are, ineffective for the purpose of, or prejudicial to, the earning of revenue, or unnecessary as tending to increase the working expenses of the railways, and generally to report on such alterations and improvements in the organisation and conduct of the business of the Victorian railways as may seem best fitted to increase the railway revenue and keep down expenses without unduly hampering traffic or production.

THE report of the Committee on Powdered Coal to the convention of the International Railway Fuel Association, says that the Delaware and Hudson Railway operates in an area where there are 550,000 tons per month of fine dust which cannot be burned on grates. The railway company built a locomotive to endeavour to use the waste anthracite product. The entire fire-box, boiler, and locomotive were of the same design as for burning coal on grates, except that pulverised-fuel mechanism was added. It has been demonstrated that the burning of pulverised fuel in suspension in the locomotive fire-box has passed beyond the experimental stage. The engine in question is conveying 13½ per cent. more than its calculated capacity of 2200 (short) tons. On the Missouri, Kansas and Texas Railroad a passenger engine has been equipped, which, instead of burning from 5 to 5½ tons of Kansas modified lump grade of coal, uses four tons of pulverised slack without smoke, sparks, or cinders, and maintains the maximum steam pressure.

NOTES AND MEMORANDA.

THE average success of all forecasts made by the United States weather bureau for all seasons and all parts of the country is said to be in the neighbourhood of 85 per cent.

GEARED marine turbines exceeding 150,000 horse-power are now being constructed in one American engineering shop. The weight works out at between 40 lb. and 50 lb. per shaft horse-power.

ACCORDING to particulars recently published, some six million shells were used in the operations that resulted in the capture of Messines. Reckoning these at an average weight of 1 cwt.—probably the average was higher—this would represent a consumption of about 300,000 tons of steel, says the *Ironmonger*.

ALTHOUGH time and again workmen have been warned regarding the danger of loose clothing when working around machinery, it appears that many of them persist in ignoring the danger. As a result, according to the *Scientific American*, 986 workmen were killed in the United States last year by being drawn into the wheels of machinery or thrown to death when parts of their clothing became caught in rotating members.

THE most important industries in Russia before the war were those devoted to distilling, textile, and metallurgical work, which together made up 84 per cent. of all the manufacturing industries of the country. The development of the copper, gold, lead, and zinc industries owes much to British capital and enterprise, 50 per cent. of the copper and 30 per cent. of the gold being produced by Anglo-Russian Companies.

IN spite of the shortage of labour and the general disorganisation of the country's economic life, the activities of the principal oil producing districts have been well maintained recently, says *Russia*. The production of oil in 1916 was actually greater than in the previous year. During ten months of 1916 the total quantity raised was 508.1 million poods, as against 476.1 million poods in 1915. The Russian Government has introduced a system of fixed maximum prices for all oil products.

As a result of research and field tests the United States Department of Agriculture announces in Bulletin 376 that wood pipe intended to convey silty water should be designed for a working velocity of from 5ft. to 10ft. per second. A velocity of about 5ft. per second will be high enough to carry out the largest part of the sand, and at the same time will not be so high as seriously to erode the pipe. It is better to provide occasional sumps for sand than to attempt to clean by excessive velocities.

NITRO-STARCH, more compact than the allied nitro-cellulose or guncotton, seems to promise great efficiency as a blasting explosive. Nitro-starch, according to the *Chemical Trade Journal*, is produced by dissolving starch in nitric acid. Ease and cheapness of manufacture, convenience and safety in use, and great explosive power are mentioned in its favour, and the advantages include non-liability to go off except when exploded by a cap, giving off no bad fumes, non-freezing quality, and a stability so great that no change was seen after ten months of storage.

SPEAKING at Luton, on Saturday last, Mr. F. G. Kellaway, Parliamentary Secretary to the Ministry of Munitions, said the monthly output of shells for the British armies in successive periods had increased in the following proportion, taking the supply in August, 1914, to June, 1915, as 100: July-December, 1915, increase to 268; January-June, 1916, increase to 707; July-December, 1916, increase to 1790; and January-June, 1917, increase to 2270. In other words, our total output during the third year of the war has been twenty times the output during the first year.

THE first submarine boat of which history makes any record was built by a Dutchman, named van Driebel, in 1640. The boat was built in England with money said to have been advanced by King James I. According to reports the vessel had a unique ballasting system. There was a number of goatskin bags placed under the deck between two large planks. These bags, when filled with water, caused the vessel to sink. To cause it to rise again the bags were pressed together again with a windless arrangement, forcing the water out, and thus giving the boat reserve buoyancy.

THE demonstrated advantages of electric motor drive as applied to steel mill service are rapidly making its use universal in rolling mill work, while as regards reversing mills, substantial evidence of the exceptional superiority of electric drive has been given during the past two years, says the *British Westinghouse Gazette*. Less than two years ago there were two electrically driven reversing mills operating in the United States and one in Canada. In November, 1916, there were fifteen mills of this type either in operation or being constructed, whilst in this country there were two.

A SELENIUM cell of 1000 times greater sensitiveness than any hitherto developed is claimed by F. C. Brown, a Californian experimenter. The improved sensitiveness of the material is said to be brought about by subliming so as to produce crystals, which are made to absorb argon, helium, or neon gas. The crystals are of varying size, but even the microscopic ones have shown no deterioration after constant exposure to intense light for twenty four hours daily for thirty-five successive days. According to the *Chemical Trade Journal*, under ordinary conditions a cell of these crystals was not lessened in efficiency after a year.

IN his report for the year ended 1916 the Comptroller-General of Patents, &c., states that applications for new patents numbered 18,602; 13,641 provisional and 10,700 complete specifications were submitted, and 8424 patents sealed, applications in 1915 having been 18,191, of which 11,457 were sealed. There was an increase of £11,417 in the receipts from patent fees. On the other hand, there was a further decrease in the receipts from design fees and sale of publications. The total receipts amounted to £292,731, being £10,260 more than in 1915. The surplus of total receipts over expenditure was £107,492, as compared with £94,298 in the previous year.

MISCELLANEA.

A WELL-KNOWN London firm of caterers is said to have decided to expend £80,000 on electric motor vehicles of the commercial type.

THE Sheffield Corporation is taking proceedings against the owners of steam wagons which do not consume, as far as possible, their own smoke, says the *Commercial Motor*.

A JOINT committee has been appointed in Dublin of the Institution of Electrical Engineers, the Institution of Civil Engineers of Ireland, and the Engineering and Scientific Association of Ireland, with the object of investigating and reporting upon the utilisation of the peat deposits of Ireland.

THE enlargement, just completed, of the main dock at Tilbury affords an addition of water area to the extent of twenty acres, and increases the available quay room by one-fifth. Along the three new berths for large ocean-going steamers have been built great transit sheds, and these are equipped with railway lines, electrical cranes, and other appliances.

IT is not generally known to London steam users that Welsh anthracite can be burned simply as mined, without grading, and that it burns perfectly without special draught. Were it better known, says Mr. W. H. Booth, in an article on "Anthracite Coal," in the *Electrical Review*, it would undoubtedly be more used, for, as a rule, the steam boilers in the London district are not overworked, and would give all the steam required, at the easy rate of combustion suited to smokeless anthracite.

THE McNicholl process seems to be the best treatment yet devised for coating a fresh cemented surface. It consists, says *Contract Record*, of zinc sulphate, 5 lb. to the gallon of soft water. The zinc sulphate forms a chemical compound that prevents the alkali from attacking the paint coating, afterwards applied. This process is also good for interior walls, over Keene's or Portland cement. When it is dry apply a coat of either pure raw linseed oil or an oil paint, thinned out with benzine.

CONTRACTS for the first ships of the new emergency fleet being built by the United States Shipping Board, under the supervision of Major-General Goethals, were awarded to the Los Angeles Shipbuilding and Dry Dock Company, Los Angeles, Cal. This contract calls for eight steel vessels of 8800 tons deadweight capacity, 426ft. long, and 54ft. beam. Each of these vessels will be equipped with four marine oil-fired boilers built for 200 lb. working pressure, each boiler containing 2900 square feet of heating surface.

THE safe arrival of the United States collier Jupiter in France with 10,000 tons of wheat is a feather in the cap of our Navy, says the *United States Army and Navy Journal*. The Jupiter would have presented a fine mark for enemy's submarines, but the strong convoys she had on her voyage evidently proved efficient. The Jupiter is a vessel of 19,360 tons, with a cargo capacity of 10,500 tons. She is equipped with an electric drive, and her speed loaded is 14.99 knots. She has a length of 542ft., a breadth of 65ft., while her depth of hold is 36ft. 9in. Her complement is thirteen officers and 157 men.

To deaden the noise from trucks rumbling over a concrete floor, a factory has successfully used a heavy tar paper pasted to the floor by paint. The method of application is as follows: The floor to be protected is first given one coating of grey cement paint. On the following day, when the paint is thoroughly dry, a second coat is applied. At the same time one side of a five-ply tar paper is painted; and when both paper and floor are still wet, the paper is carefully laid, wet side down, on the floor and rolled with either a roller or wide-tired truck until all signs of air-pockets beneath the paper disappear. The surface, says *Contract Record*, seems to improve with age, and very effectively reduces noise at a low cost.

VERY good results are said to have been attained in the experimental manufacture of square and bar steel, &c., at the Kawasaki Dockyard Company's branch factory at Hyogo, where two 15-ton smelting furnaces were installed last year. Encouraged by these results, the company has decided to establish a steel works on an extensive scale for the manufacture of steel plates and rails, says *Eastern Engineering*. A suitable site is being sought in Fukuoka Prefecture, Kyushu. When the site is fixed, a large works, with five 30-ton smelting furnaces to begin with, will be erected on a capital of 5,000,000 yen, for manufacturing steel plates, rails, square and bar steel, &c., the same as the Government Steel Works at Edamitsu.

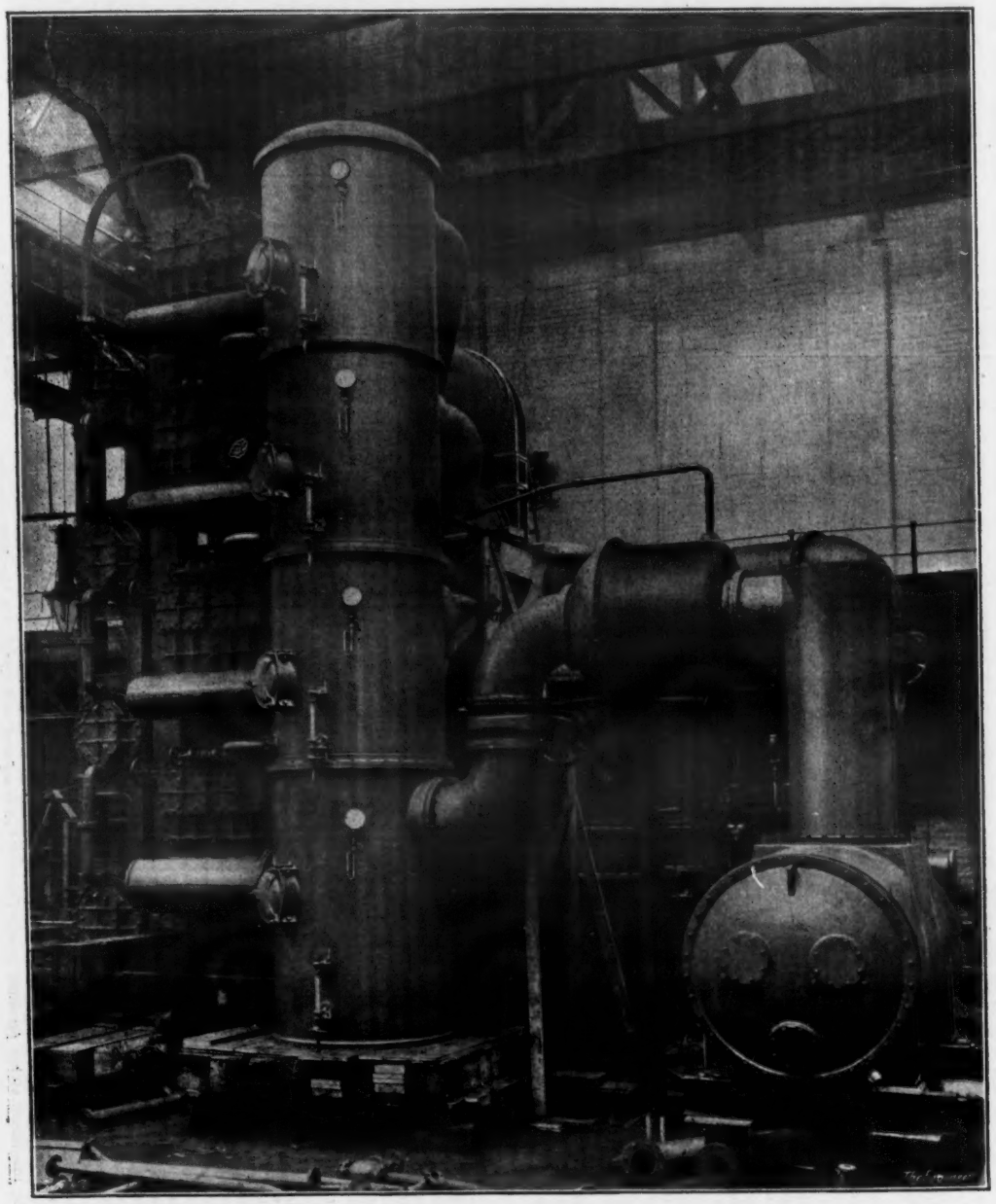
AT a recent meeting of the Birmingham District Power and Traction Company, Limited, the chairman, Mr. C. S. B. Hilton, pointed out that at present every motor omnibus in regular work contributes a ½d. per mile, or between £50 and £60 per annum, in taxes. It was originally arranged that such taxes should be spent on road maintenance, but during the war the revenue from this source has been diverted to other objects. Meanwhile, individual road authorities were endeavouring by other means to compel omnibus owners to contribute to the repair and up-keep of the roads. This policy he regarded as very unsatisfactory. It will undoubtedly have the effect of seriously crippling the development of motor transport in the public interest.

THE future of the British X-ray industry will depend upon the ability of the British manufacturers to hold their own against those of other countries. The world's markets will be captured by that country which can combine the largest capital with the greatest initiative and fertility of invention. British manufacturers in other directions in the past have been able to hold their own; there is no reason why the British X-ray industry, if sufficiently capitalised and guided by the best skill in the country, should not be able to do the same in open competition with other countries. According to *Nature* American manufacturers have already advanced to the stage of amalgamation and pooling of interests. The capital invested amounts to a considerable sum—£250,000, or thereabouts.

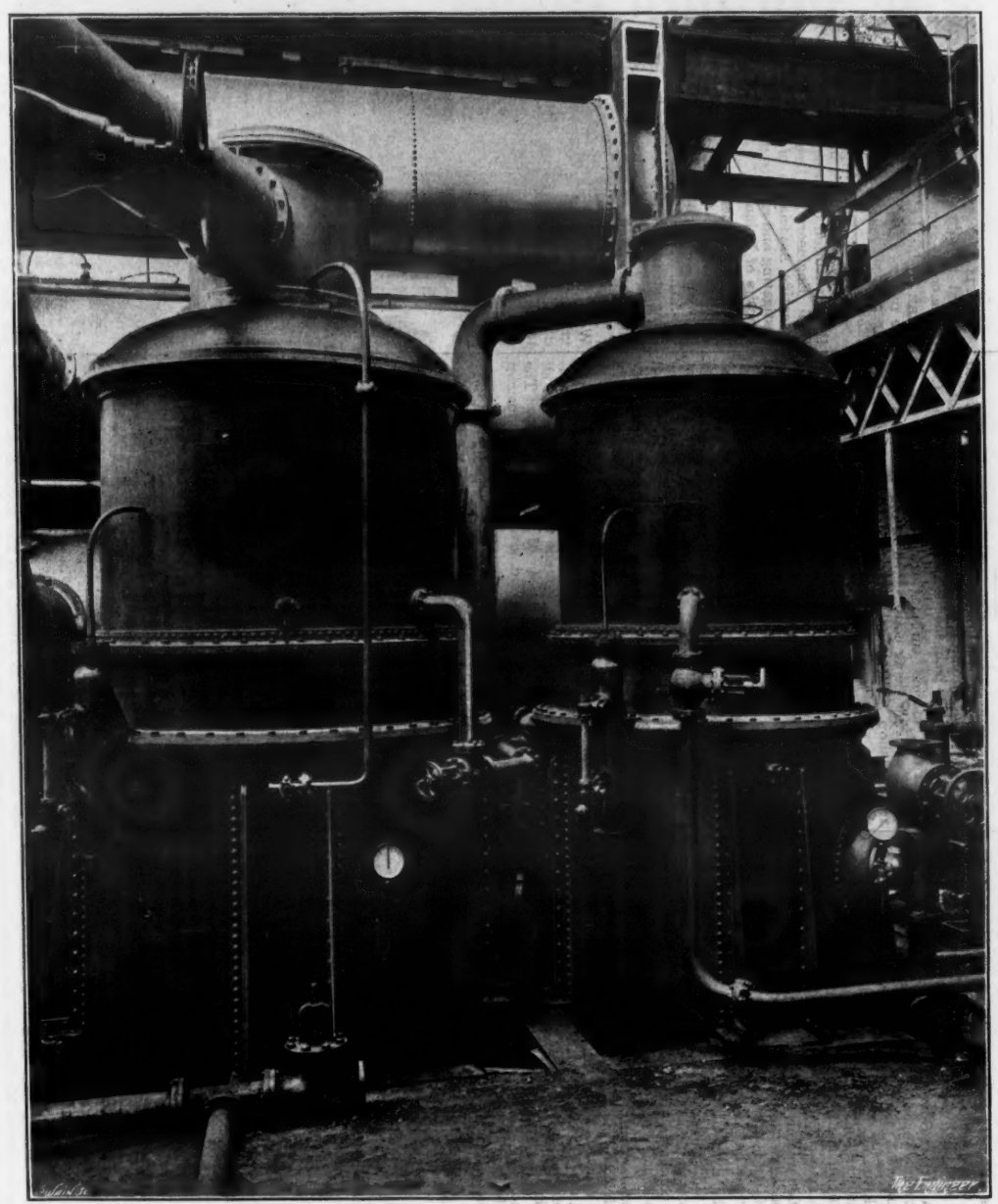
CAUSTIC SODA CONCENTRATION PLANT

THE MIRRLEES, WATSON COMPANY, LIMITED, GLASGOW, ENGINEERS

(*For description see page 44*)



QUADRUPLE EFFECT CONCENTRATOR



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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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*** *With this week's number is issued as a Supplement a Two Page Drawing of a Tank Locomotive for the Paris-Orleans Railway. Every copy as issued by the Publisher includes a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☛ *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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INQUIRIES.

FITT-ALL LATHES.

SIR,—I should be much obliged if any one of your readers could give me the name and address ofthe makers of "Fitt-all" lathes. W. L.

DEATH.

On the 8th inst., at 19, Edith-grove, Chelsea, THOMAS WHARTON FORD, M. Inst. C.E., M.I. Mech. E.

THE ENGINEER.

JULY 13, 1917.

The Duties of the Air Forces.

ON Monday evening the Prime Minister took the exceptional step of clearing the House of Commons of "strangers" in order that he might make a secret statement on our air forces to the members, particularly with regard to the raid upon London last Saturday. Of the wisdom of secrecy the Cabinet is the best judge; it alone is able to say whether the information in its possession is such as ought to be put before members of Parliament, and must yet be kept from the people of the country. But in the official *précis* of Mr. Lloyd George's speech there is as much clearness as can be desired on one point at least. We have not enough flying machines, and that is in substance and fact the gist of the whole matter. Had we more the towns and cities, the harbours and works, of England might be more adequately defended. To criticise the administration for this lack of machines is barely just. It has, as the Prime Minister stated, been making the greatest exertions to augment the output, and it looks forward to a very great increase at an early date. But it has had to provide war material of all kinds in amazing quantities, and the resources of the country are taxed to their uttermost. Had it given more attention to aeroplanes it must have given less to shells and to ships, and if either of them had been lacking it would have been accused of negligence. We know, we admit, of apparent cases of mismanagement in the organisation of aeroplane manufacture, but on the other hand we know that machines are being turned out in ever increasing quantities, and that after many trials types have been discovered that meet all requirements. In twelve months, said Mr. Lloyd George, we have added twenty-three thousand men to the number of employees in aircraft factories, and we have "enormously improved the type of machines," and "our production in now going up by leaps and bounds." Finally, he asked the civilians of the country to bear the anxiety for a short time longer. "It was only," he said, "for a very short time, and he was confident that we would then not only secure supremacy in France, but also equip Lord French in such a fashion that if the Germans came over again they would deem it the part of wisdom not to repeat the attempt." We must accept his assurance that every effort is being made to meet the demand, and believe him when he tells us that a short time hence we shall be in possession of an abundant supply.

In the meantime we observe with some satisfaction that the call for reprisals is abating. It is not that there is less demand than there was for retaliation, but that the demand is inspired by more intelligent motives. The cry for reprisals was very largely a cry for vengeance. Men and women of Britain sought to do to the Germans what the Germans had done to Britain. Like vengeful litigants, they would ruin themselves rather than let their enemy escape. That is the road of sheer folly. There is one object, and one object alone, in front of us all—to win the war. If reprisals can be defended as a military measure; if it can be shown that they will lead to an earlier defeat of the Central Empires, if they will embarrass Government, delay supplies, cause internal seditions, and hasten the overthrow of the enemies' moral, then reprisals are justifiable military measures—and reprisals is the wrong name for them. We know assuredly that the air raids now directed by our military authorities do all these things; we do not know, and we cannot know, that air raids carried out against defenceless towns in Germany would have one particle more effect upon the progress of the war than air raids on London. Moreover, every raid that is directed against an object not of military importance involves the misuse of materials and the loss perhaps of lives that could be used for a better purpose. It is the widely held belief that Sir Douglas Haig is maturing another blow. It is of incomparably greater importance that he should have at his command every aeroplane we can muster than that some should be sent on dangerous expeditions for the satisfying of vengeance, or even that large numbers should be retained at home for the protection of civilian lives and civilian property. The enemy is trying to probe into his secret. A squadron of thirty planes sought a few days ago to do what single machines had failed to do. Against such squadrons he must be able to oppose others of equal strength. The enemy must not be allowed to see our military preparations. It is admitted that we have none too many machines; not a single one must be taken from our armies at the front without the express approval of the Commander-in-Chief. We do not know fully the motives that inspire attacks upon London, but we do know that those attacks would succeed in one object if they caused us to withdraw from our armies machines that are needed by them. Better is it that English towns and English civilians should suffer more severely than they have yet suffered than that a blow which we all hope is impending, and which Germany fears only too keenly is about to fall, should be weakened by the thousandth part of its weight. What the aeroplanes did at Messines they may be required to do in Sir Douglas Haig's next attack. To withdraw a few score machines at this juncture of affairs for the satisfaction of vengeance, or for the higher motive of protecting our own towns from what we know to be futile attacks, would be the height of unwisdom. The time may come, the time may be rapidly approaching, as Mr. Lloyd George hinted, when we shall have aeroplanes enough and to spare for any duties to which it may be desirable to put them. When that time has arrived it will be the moment to discuss whether reprisals are the best form of defence, or whether the retention of powerful protective squadrons in the neighbourhood of our coasts is the better course. But until that time comes we shall only serve the enemy's turn, we shall only do just what he desires we should do, if we rob our military forces of a single machine that they can put to an immediate military use.

It is said that if we carried out raids into German territory we should oblige Germany to keep at home aeroplanes to protect her towns. That will be an argument of much weight when we have an overabundance of machines, but the obvious end of a policy of the kind would be that both in Germany and England a large number of machines would be retained for the sole purpose of repelling hostile attacks which, as a consequence, might never take place. On both sides these machines would be as much use in bringing the war to a conclusion as the fixed defences of the two countries. An offensive could not be carried out with them, and it is an offensive we want. Germany would be glad enough to see the offensive suspended; she would gladly wait in the hope that political events would give her a victory her arms have failed to secure. For us the offensive is everything, and we cannot contemplate calmly any action that would deprive it of its full effect. If it be successful we are confident that it will bring about more rapidly the termination of hostile air raids than any number of reprisals directed at objects which are not specified by the military authorities at the front as of military importance. We cannot but hold that if public clamour should move the House of Commons to call upon the military to take a step of which it did not heartily approve, and of which it was unable to say that it would hasten the hour of victory, and hence of the advent of peace, it would be guilty of a course which would delay those great objects, and would cause far greater loss of life and destruction than many raids.

An Industrial Parliament.

IN our last issue we discussed the official views, the views of the Reconstruction Committee, of the right direction in which to search for industrial peace. The method proposed is a conciliatory method, it presupposes that each side will be ready to give and take, and that nearly all differences can be dissolved by friendly discussion. The Committee advises the setting up of a triple-machine, consisting of Works Committees, District Committees, and a National Council. All three would have a permanent existence. They would not be called into being only when trouble

was brewing; before ever it had begun to ferment, they would have handled the problem and removed the cause. The Committee, we pointed out, gave form and substance to an idea which has been in the air for many a day, and began to take form in the meetings of the National Alliance of Employers and Employed early in the present year. It is believed that deep down in the mind of both employed and employer, there is a deal of sound British common sense; that both parties would rather agree than fight, and that a reasonable way out of all difficulties is to be found. This view may be too sanguine. Conciliation in the past has not been always successful, and it is too much to hope that human nature has been so changed by the war that it will in the future effect what it failed to effect in the past. But we should do the country a grave dis-service if we opposed it. Against the settlement of industrial problems by argument and reason, what is there to place? Nothing but force; nothing but the strengthening of the employer till he can overpower the employed, or of the employed till he can overpower the employer. According to the point of view taken, we may believe either that a beneficent autocracy of capital or a beneficent autocracy of labour would be best for the world; but in either case, we must admit that there would always exist a powerful opposition, that always the ruled would be trying to take the place of the rulers. Not so many years ago, this would not be a subject for discussion. The employer was then "the master," and wielded the power and the rights of that position. He controlled his factory and his business as he pleased, and did as he would with his labour. But times have changed. The employer is rapidly ceasing to be "the master"; he is now the director, the organiser, and his work is carried out as much for the benefit of labour as for his own benefit. In these circumstances, we have to look at industrial problems in a new light, and under the influence of them it is being gradually admitted that labour has a right to be consulted about many questions connected with factory organisation. It is now a tenet of faith—faith, because it is not yet subject to proof—that by this means, and this means only, is industrial peace to be won.

The scheme propounded by the Reconstruction Committee emanates as much, or more, from employers as from employed; but since its appearance we have received a memorandum of proposals which breathe the same spirit, which are in part, at least, of the same kind, and which sprung originally from a trades union. In its own words, it "is the outcome and expression of a desire on the part of the leaders of organised labour in the building industry to render their full share of service towards the creation of a new and better industrial order." It recognises that the old condition of labour and capital armed continually *cap-à-pie* for war, did not make for peace. It does not dare to believe that the total elimination of conflict is possible, but "the hope of the future undoubtedly lies in the intimate and continuous association of both Management and Labour, not for the negative purpose of adjusting differences, but for the positive purpose of promoting progressive improvement of their industrial service, from which alone the national prosperity can be derived." "Industrial peace," it continues, "must come, not as a result of the balance of power, with a supreme court of appeal in the background; it must arise as the inevitable by-product of mutual confidence, real justice, constructive good-will. Industry needs no truce, no compulsory arbitration, no provision for postponement of disputes. What it needs is confidence and a courageous forward movement, supported by the constructive genius of both sides in common council." Believing that the appropriate time has now arrived to introduce a new harmony, "the National Federation of Building Trades Employers of Great Britain and Ireland and the National Associated Building Trades Council submit the following scheme for consideration and approval." This scheme, which it will be observed is supported by the employers' federation, is to set up an Industrial Parliament for the Building Industry. "The objects of the Parliament would be to promote the continuous and progressive improvement of the industry, to realise its organic unity as a great national service, and to advance the well-being and status of all connected with it." We need not deal here with the work or the constitution of this Parliament. It is the spirit of the proposals rather than their details that for the moment interest us. Surely it is a sign of the times when the two largest organisations in a trade which has always been subject to disturbances, conclude that by conference they can settle matters that have hitherto been decided by a trial of financial, physical or political strength. Surely it is a good omen that the desire for peace should exist, and that employers and employed, instead of, as hitherto, continually appealing to Parliament to give them new powers that may make them superior to their opponents, decide to dissolve their differences in friendly conference, conferences not called hurriedly for the specific purpose of dealing with a trouble already in existence, but conferences conducted with deliberation at a time when men's minds are free from the rancour of dispute, and when all the facts of the case can be seen in the clear light of reason.

It would be easy indeed to ridicule this Parliament of industry, to dub it a debating society, to prophesy for it a stormy future, or to see in it the beginning of a new political clique. We are not blind to the fact that it is open to criticism, but we deliberately close our eyes to its present or prospective faults. It is the spirit that has inspired its creation that matters. The Parliament itself may fail ignominously, but that there should be any attempt to set it up, that two bodies, which in the past have been ready to fly at each other's throats, that the representatives of capital on one side and of labour on the other should express of their own accord a willingness to come together for the amicable discussion of the affairs of their common industry, these are signs of grace of which we cannot over-rate the importance. Labour difficulties of a very serious nature lie ahead of us. They can be solved only in two ways, either by the exercise of unchallengable authority, or by the agreement of the parties. The former is the practice of the past. We know that it has failed. We know that neither labour, nor capital, nor Parliament was ever strong enough to control the tantrums of industry. Let us then welcome the alternative, for it holds out at least the promise of a success which the other failed to achieve.

The Coal Transport Reorganisation Scheme.

NOT all the influences of war have been for evil; many have been for good. In the national, political, and industrial world the stress of conflict has brought about changes of thought and action that have not only contributed towards the successful achievement of the great object we have before us, but have been of such benefit that many of the new ideas are likely to be retained permanently. In the railway world many changes of great moment have been made, not only in the relation between railways and the public, but between the railways themselves. Services, freely rendered, which competition between the companies had forced the railways to give to traders, have been withdrawn, and it is certain that few if any of them will be restored; whilst the pooling of receipts, and the working of traffic in common, have brought modifications in the inter-company arrangements of an important kind. But of all changes, probably the most effective are those relating to wagons, *i.e.*, the pooling of railway-owned wagons, and the authorisation, under the Defence of the Realm Regulations, of a railway company to use the privately-owned wagons of a trader. The Controller of Coal Mines has now introduced an even greater revolution. This scheme, as mentioned in the adjoining column, is to be brought completely into use by September 10th, and has for its object the reduction of long journeys and cross-country travel of coal, other than anthracite, required for inland consumption. The long journeys demand a great use of trucks and consumption of engine power, whilst the cross-country consignments need generally many trucks and much power, and, in all cases, call for shunting movements, which not only require power but staff as well. In our description of the new scheme it will be seen that the whole of England, Wales and Scotland has been divided into areas. The areas are twenty in number, and, according to information supplied to the Controller of Mines by the Railway Clearing House on traffic passing in December last, each of these areas, except three, not only sent coal to other areas, but itself consumed coal brought from other areas. The three exceptions were the Eastern Counties area, Northants to Essex area, and the South-Eastern Counties and London area, none of which produced coal for consumption in other areas. Altogether the number of exchanges between areas was three hundred and twenty-two. Under the new scheme the number of exchanges is brought down to seventy-eight, a reduction of 75.77 per cent. The areas that will not send coal to other areas are now six, whilst two will not require any brought in.

It is estimated that the proposed reorganisation will effect an economy of 700 million ton-miles, but as this does not convey any idea as to the extent of the economy, other estimated figures may assist us in arriving at a clear appreciation of the extent to which the railways will be relieved. These figures give the tonnage that will come under the scheme of the Controller of Coal Mines as 42 millions. Seeing that, according to the Railway Returns Blue-book for 1913, the railway companies, during that year, conveyed 227 million tons of coal, we may take it that the new scheme applies to between one-fifth and one-sixth of the rail-borne coal in the country. The general merchandise conveyed in 1913 was 73 million tons, and other minerals than coal 72 million tons; it is apparent that the reorganisation is going to effect a great economy in locomotive power and in trainmen's wages. Savings, too, will be forthcoming from the less shunting required, and here there should be a greater proportionate saving than in train mileage, seeing that one of the objects of the scheme is to make the traffic flow in regular channels. Again, whilst we cannot estimate what the saving will be, it may be noted that in 1913 the railways of England, Wales and Scotland ran 155 million goods and mineral train miles, and that the goods and mineral shunting miles were 115 million. Next to the railway companies the parties who will possibly benefit most by the new scheme will be the proprietors of the privately-owned wagons. From the evidence given in March, 1915, before the Departmental Committee on Retail Coal Prices, it would appear that the owners of these wagons charge a certain amount per ton per journey. As the journeys under the reorganisation will be shorter there is a possibility of wagon owners benefiting by the scheme, especially as the coal factors and merchants are somewhat at their mercy. There is, however, a remedy for this, as under the Defence of the Realm Regulations the Board of Trade may take possession of any wagons. The consumer is not likely directly to benefit in the price of his coal owing to the shortened railway journeys, as the carriage charges are already very low. He may, however, expect to get a more regular supply, and this will be an important factor. How he will manage without classes of coal he has hitherto been unaccustomed to use, and how this particular situation will develop after the war, are matters that remain to be seen. The main thing is that, under the reorganisation scheme, suppliers and consumers will be within closer reach of each other, and that the transport of coal will be reduced and simplified.

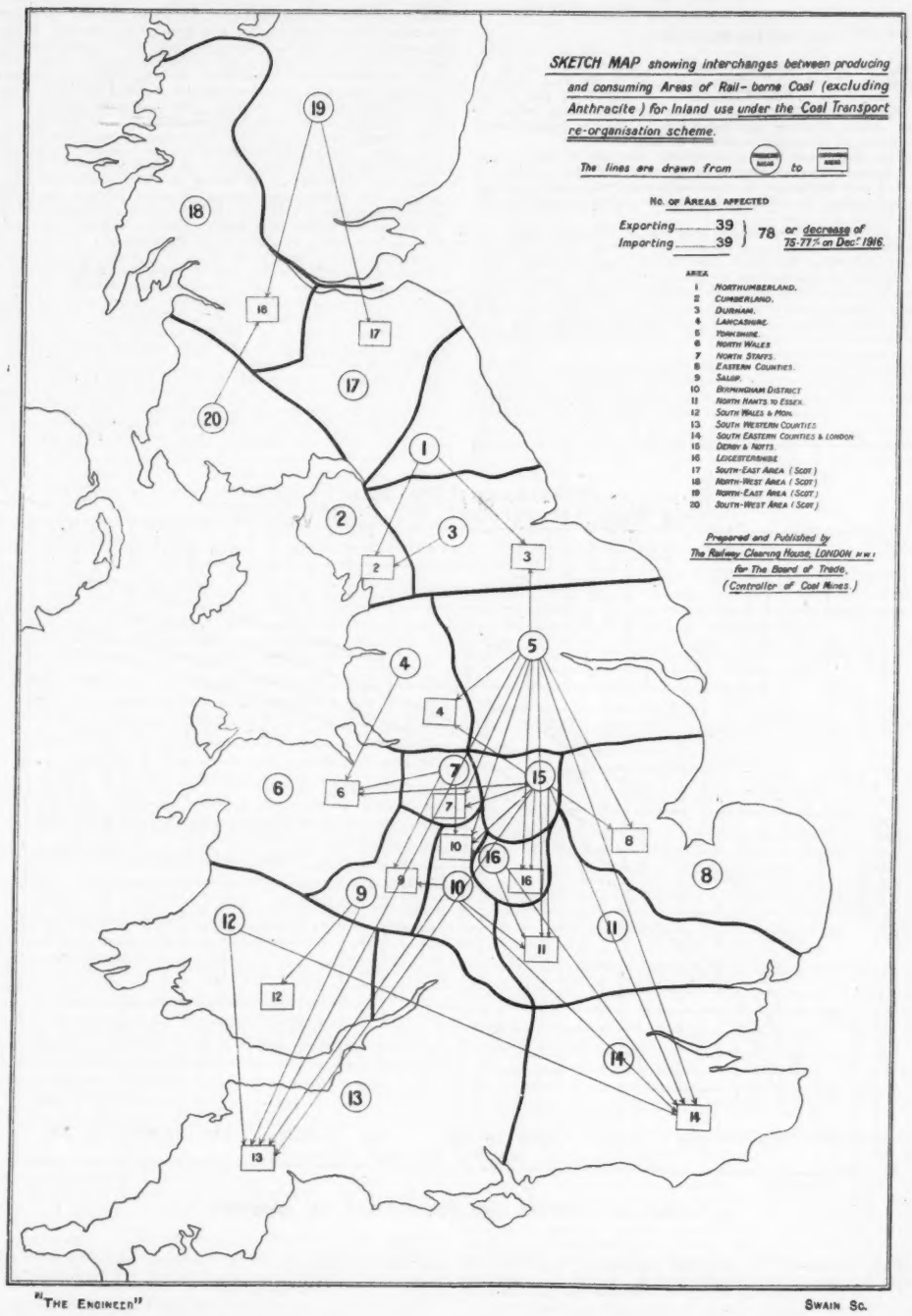
NEW SCHEME FOR COAL SUPPLY.

ON and after September 10th next, the national supply of coal will be conducted on an entirely new basis, and although it is obvious that the scheme put forward by the Coal Controller will be associated with a certain amount of inconvenience, there is a general disposition to believe that it has been well thought out, and should operate on the whole satisfactorily.

The main object underlying the scheme is to relieve the strain on railway transport, the pressure on which, by reason of staff depletions, the loan to the military authorities in France of large numbers of locomotives, rolling stock and track, and the increasing demands of war traffic on home railways, has gradually increased to a point where it has been necessary to take drastic steps to reduce goods train mileage. In normal times the railways have to handle annually about 42 million tons of coal, much of it for long hauls. The immediate object of the Coal Controller, himself an expert railway administrator, is to eliminate the long haul, and it is estimated that the scheme now put forward will save no less than 700 million ton-miles in the transport of coal by public railway, without, it is understood, taking account of the reduction in empty wagon mileage, already considerably reduced by the adoption of the common user of wagons scheme or taking any credit for the saving in marshalling and shunting operations. There should also be a much better turnover of wagon stock, minimising stoppages at collieries, due to delays in the return of trucks.

For the purpose of putting the new system into force, Great Britain has been divided into twenty areas, as shown on the accompanying plan, and the scheme relates solely to that portion of the coal which is being transported from area to area for inland consumption. The principles underlying the future method of supply are, that consumption of coal should take place as near the producing point as possible, that in view of the superior facilities traffic should follow main trunk routes whenever this can be arranged, and that the movement of coal should, as far as possible, be in well-defined directions, north to south, north to south-east, north to south-west, and east to west. Further provisions are that an area which produces less coal than suffices for its own needs shall not send any portion of its output to other areas, and that an area producing an excess tonnage shall only distribute the balance to adjacent or convenient areas. The only exceptions to this regulation will be made in the case of munition works and other industrial establishments which must be provided with fuel of a special type. For this purpose certificates will be issued by the Coal Controller, authorising the supply of the grade of coal required, and in the absence of such certificates collieries, factors and merchants will be precluded from supplying special grades to consumers. Movements of coal within the various areas will remain undisturbed, and

COAL DISTRIBUTION AREAS OF GREAT BRITAIN


SKETCH MAP showing interchanges between producing and consuming Areas of Rail-borne Coal (excluding Anthracite) for Inland use under the Coal Transport re-organisation scheme.
The lines are drawn from to
No. OF AREAS AFFECTED
Exporting 39
Importing 39
78 or decrease of 75·77% on Dec.r 1916.
AREA
1 NORTHUMBERLAND.
2 CUMBERLAND.
3 DURHAM.
4 LANCASHIRE.
5 YORKSHIRE.
6 NORTH WALES.
7 NORTH STAFFS.
8 EASTERN COUNTIES.
9 SALOP.
10 BIRMINGHAM DISTRICT
11 NORTH HANTS. to ESSEX.
12 SOUTH WALES & MON.
13 SOUTH WESTERN COUNTIES.
14 SOUTH EASTERN COUNTIES & LONDON
15 DERBY & NOTTS.
16 LEICESTERSHIRE.
17 SOUTH-EAST AREA (SCOT.)
18 NORTH-WEST AREA (SCOT.)
19 NORTH-EAST AREA (SCOT.)
20 SOUTH-WEST AREA (SCOT.)
Prepared and Published by The Railway Clearing House, LONDON N.W.1 for The Board of Trade. (Controller of Coal Mines.)
"THE ENGINEER"
SWAIN Sc.

contracts for these local supplies will not require to be cancelled, but all other contracts will automatically terminate on September 8th next.

New contracts for supplies from the specified area are to be arranged between now and that date. The District Coal and Coke Supplies Committees, which were in existence before the appointment of the Controller, have been empowered to conduct the necessary arrangements in respect to new contracts, but although they have given good service in the past, it has been deemed necessary in view of the national character of the new scheme to add to each of the committees a man of high position representing the public life of the district, but who has no connection with the coal trade. The main work of the committees in the future will be to put the collieries in each area in direct touch with the factors, merchants and direct consumers, whose supplies they will have to provide, obviating the need of consumers themselves seeking for new sources of supply, or of collieries seeking new customers. It looks, at first sight, as if this plan may not work quite satisfactorily, and there is the further fear that a ring might be formed in each area against consumers who, compelled to cancel old contracts, might be forced into new contracts on unfavourable terms. It is understood that both these difficulties have been foreseen, and it is hoped provided against. On the question of price, it is believed that the Coal Prices Limitation Act, which hitherto has not been found to achieve the desired result, will be rigorously enforced by the Controller, to whom all complaints on the question of excessive prices should be addressed.

The effect of forcing certain classes of consumers to accept deliveries of coal which are not suited to the duty required—for example, no Welsh coal, except anthracite, will come to London—is bound up with the stringent provisions regarding smoke abatement in the London district and other large cities, but it is understood that although the Local Government Board will not suspend the operations of the laws governing smoke abatement, these will, when the new scheme comes into force, be interpreted with a considerable degree of latitude. In the evolution of the new system, there has been a free interchange of views between all parties concerned, and the Controller is in touch with the Railway Executive, with a view to ensuring that adequate arrangements are set up to meet changed conditions in the flow of traffic. It should be emphasised that this scheme does not affect water-borne coal, either export, coastwise, or bunkers, anthracite, or coke of any description. Detailed arrangements for domestic supplies in London, and it is to be assumed other large centres of population, are to be the subject of a separate subsidiary scheme, which is being drawn up with the co-operation of the municipalities.

EFFICIENCY.

By A. L. HAAS.

THERE is a current tendency to deprecate the term efficiency as understood in modern manufacture; we are invited to reflect whether or not an efficient world would be interesting, and in the best interests of all concerned. Scientific management and all it implies, is being seriously questioned; coupled with the distinct restlessness of labour and the problems of industry generally. Labour itself feels that highly organised and systematised manufacture is used to exploit it, and rebels against a movement which seeks to utilise it in the best manner. Whatever may be done to reconcile conflicting interests, it is definitely certain that the march of progress cannot be delayed by any pious wishes to arrest the hands of the clock. There are, for example, two modern schools of thought, each believing that its conclusions are for the betterment of mankind. One wishes to revive handicraft and discard mechanism and modern industry, believes, for example, in reviving mediævalism. The other, foreseeing that mechanism and all it involves means freedom from the worst features of toil, wishes to advance rapidly. Both are agreed that the resultant accumulation of wealth should be better distributed.

Now those who by inference plead for inefficiency, for the march of progress to be stayed, fail to consider some very obvious facts. The newspaper journalist who voices the matter would not like to be regarded as an inefficient and slipshod writer. If he wants a pair of boots he wants them to be serviceable; or, alternatively, he desires efficient boots. Unless the shoemaker were efficient he would be a useless encumbrance for the community to keep, however delightful a conversationalist he might be, for example.

We are duly informed that industrial conditions to-day produce wage slaves, having no freedom to express individuality; who for this reason must, of necessity, degenerate into automatic sectionalised producers. Everyone in the business is aware that there are inefficient operators on simple jobs, so that efficiency is not the product of sectionalisation as such. What really matters is that labour shall have adequate reward in terms of life and leisure for those finer things which lend interest and provide relaxation. To do this, actual and positive wealth must be increased, and all modern tendency is to the creation of such potential credit. It is moreover certain, that at no period of history, were there greater numbers interested in literature, art, and the matters which concern creative endeavour. If the spectre of commercialism be touched to finer issues, and the ghost of exploitation be laid, then there is a reasonable prospect of a new era.

Efficiency is of prime national importance, nay more, it is of universal benefit; it should directly lead to shorter hours and a higher and more leisured plane of existence for everyone. The greater the wealth the greater the comfort. The artisan standard of to-day in the United Kingdom and the United States of America is essentially in advance of that open to the Kings of past ages in most of the things which matter. If the ultimate working day becomes reduced to, say, six hours alternating the round of the twenty-four, the outcome is greater leisure. It is admitted that labour *en masse* does not perhaps make the best use of the scant amount of leisure now afforded, but this is no argument, that with higher standards of education, and advance in social ideal, future labour is also going to misuse its greater amount of spare time.

There is only one method to ensure shorter hours, increased real wages, and better conditions for everyone, and that is by the road of efficiency. It really does not matter how economic independence is achieved, it must, however, be preliminary to relaxation. With livelihood and a rational existence assured, with the dread penalty of starvation not due to default, absent, there will be time to develop natural gifts and the re-creation of personal and individual talents will become usual. It is the distribution of the wealth created which causes present troubles; fairer methods, due to more advanced ideas, will serve to make real effort a point of honour. Nature has been bountiful in her provision for man's need. Man has evolved mechanism for the exploitation of Nature's gifts. Efficiency means that the community as a whole obtains the utmost from the transference of energy; wresting natural law to serve man's need. If the efficiency serves the community in which all share, nothing can be urged against the methods of its operation. Where systematic exploitation is practised for individual gain, it matters not whether this is by means of scientific management or unlawful possession of natural resources; there must needs be a state of warfare between the hirer and the hired. Without labour there can be nothing but a wilderness; it is only by labour that man can establish civilisation and all it implies. To-day labour is shut away from natural resource, and because there is no choice between starvation and toil, man having no alternative, must will to live by labour. Some folk think he should find pleasure in industrial toil, and a few actually do find such reward for their efforts, always however, where natural inclination has been afforded choice. Destitute of choice, lacking possessions, forced into distasteful work as an unwilling recruit, it is small wonder that masses of the industrial population lack enthusiasm for proven methods, whereby greater effort is induced and bigger results achieved. No thoughtful engineer can be uninterested in the social aspect of the questions at issue, or can afford to disregard the effects of communal mismanagement which he must study to understand the point of view of labour.

The systems termed scientific, which by a variety of means all foster greater output, never by any chance include a shorter working day for the efficient; making shorter hours the bribe for more strenuous toil. Bonus systems on a time limit basis all are worked on time saved from a specified period set. If the time so saved served to shorten the actual day it might conceivably do more than any system of reward in a pecuniary sense. Any manager of experience can quote instances where time was the essence of

the contract on overtime work. The promise of a night's pay for a specified piece of work meant in most cases that midnight saw the work completed. Here is a fixed payment, the variation being that the efficient shortened their period of work to earn remission of sentence. It is tried with good results in the case of prisoners for crime, but not for those who are free citizens earning their daily subsistence. The suggestion is made in all seriousness for the consideration of the scientific manager whose motto is efficiency. Another incentive whose results are in most cases surprising is to put responsibility upon the man. There are few men who do not shape up under the treatment, for it is the underlying basis of all valid contractual relations. The difficulty under usual industrial conditions is to provide a penalty clause as well as consideration of value.

In an army where it is useless to upbraid destiny, where perforce the penalty for infraction of discipline is enforced with swift justice, where pay is fixed, the recruit finds that efficiency is the only road to leisure. Hence the necessity of the case leads to efficient soldiers. If an army is inefficient the penalty is imposed by the enemy. It is realised by all that efficiency is the only way to victory, and all this implies. There is no suggestion here that industrial conscription is a solution, or that military methods applied to works management would improve relations, but he would be dense indeed who failed to realise the underlying truth. Where the interest is identical, co-operative effort in the most monotonous labour is cheerfully obtained. In face of actual danger there is, by reason of past discipline and resultant efficiency, a smoothness in the mechanism of the machine whose components are human. Industry desires a similar end without the stimulus of patriotic service and the realisation of identity of interest.

No one is a more severe critic of mismanagement, even if it favour himself, than the normal workman. Yet on the other hand, he is a sworn foe of the speeding-up process and of scientific management generally. Were the point of view changed, in that he was enabled to do his work with less fatigue ; and, becoming efficient, so shorten his working day by expertness, there might be a reversal of idea on the workman's part, and a welcome extended to progressive manufacture. It is resentment against exploitation which is the fundamental which underlies labour unrest.

The workman, like his employer, has only one life to live, and under normal conditions cannot claim more than three or four hours at most out of each twenty-four as his own exclusive property. In other words, his life is shortened to less than one-third of its actual duration ; he is free only when at leisure, and when transit to and from, and meals and sleep are subtracted, what is left is not a deal. All men who work for hire, whatever their position, are more or less in the same case. Increase in total wealth, should by shortening hours of toil, increase the duration of effective life, lived as the owner chooses. It should be possible by proper conservation of energy, by full utilisation of known means, so to multiply effort by mechanism that present working hours would ultimately be halved. This of course premises that all without exception work. Conditions at present existing have familiarised the population with the idea that to be idle in the national interest is a personal disgrace. To be idle at any time in the sense of performing no specified duties, is a disgrace, although not realised as such. Greater leisure for the workman, and more work for the economically independent, is a prescription of a national character, which at the moment is in operation, and which should persist in times of lessened stress.

It is not for nothing that the normal length of working day came into being ; it could be shortened with advantage. Overtime never pays either the workman or the management. Where adequate payment was made, the more thoughtful would, if possible, refuse to work abnormal hours for more than short spells, as effort is not proportional to duration of toil, but to potential energy renewed in leisure. Put in another way the total expenditure of energy over a given period is roughly equal, irrespective of the time worked. It may even be said that long hours spell inefficiency, and the fact is too well known to argue by specific instance. Proportionate production must inevitably fall where excessive overtime prevails.

To lessen fatigue by the right application of effort is the end to be sought ; add to this reward in leisure, and provided a living wage is paid, efficiency will result—such is at all events the argument here elaborated.

REPLYING to a question in the House of Commons recently, Dr. Addison (Minister of Munitions) said that no employees of iron merchants had been badged as such, or protected under the Schedule of Protected Occupations, M.M. 130. The Schedule provided for the protection of certain classes of employees of scrap metal merchants, the reason being that the collection, treatment, and distribution of scrap iron and steel was essential to the fulfilment of the programme of construction of ships and the manufacture of munitions, and could only be carried out if a certain number of qualified and experienced men were retained to perform the work.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FUEL ECONOMY.

SIR,—In your issue of June 29th, under the heading of "Random Reflections," reference is made to Mr. J. A. Robertson's paper on "Fuel Economy," presented at the recent meeting of I.M.E.A. In this paper Mr. Robertson refers to higher steam pressures and temperatures than at present used, as a means of obtaining economy in fuel.

As the writer has been a consistent advocate of these means for securing fuel economy, and has designed and operated a plant of this nature for a considerable time at Rugby, perhaps you will permit the following information being put before your readers :—

At the British Association meeting at Dundee, 1912, Mr. Dugald Clerk read a paper on the Gas Turbine, and in the discussion following the paper, the writer suggested that whilst waiting for the gas turbine to become practicable, a good deal might be done to improve the economy of steam plants, by using higher steam pressures and temperatures. He contended that a fuel saving of 15 to 18 per cent. was certain, and that experiments on a fairly large scale were about to be started to prove this contention.

The directors of the British Thomson-Houston Company, Limited, provided means for manufacturing and installing a plant of 1500 kilowatts capacity, using extra high pressure steam, and this plant was put into commercial service about 2½ years ago.

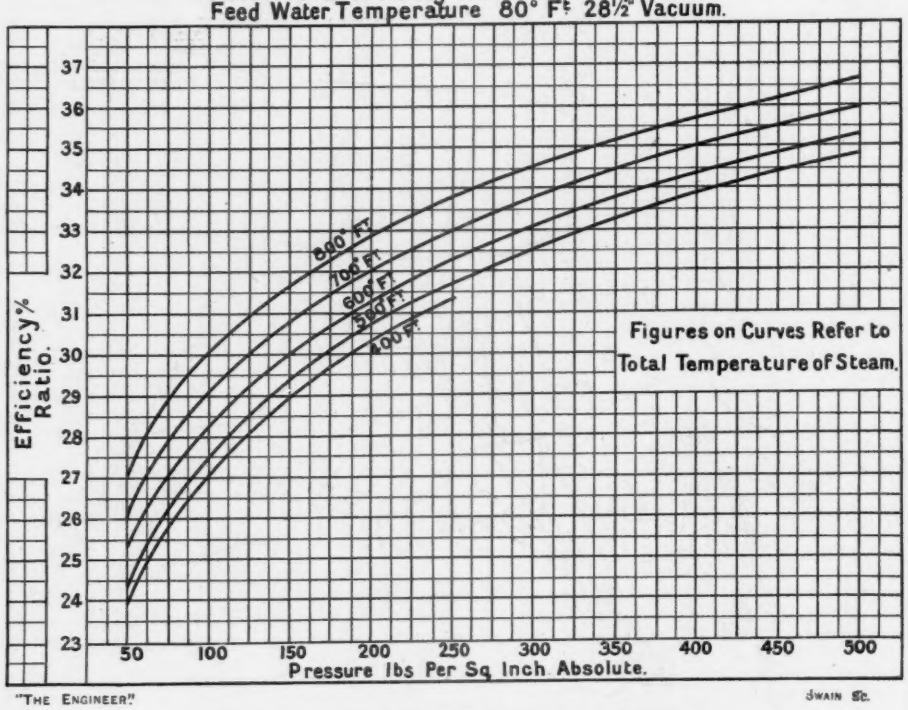
Engineers interested in thermo-dynamics will know that for a given temperature the total heat required to be put into the steam decreases as the pressure goes up, and at the same time more heat is available for work. For readers not familiar with the properties of steam, it may be of interest to see this relationship in the form of readily interpreted curves. The curves given below are based on adiabatic expansion, on the feed water entering the boiler at 80 deg. Fah., and the expansion is taken down to a pressure equal to 28½in. vacuum (bar. 30in.). The efficiency ratio shown on the curves is derived from the relation of :—

$$\frac{\text{Heat available in steam}}{\text{Total heat in steam.}}$$

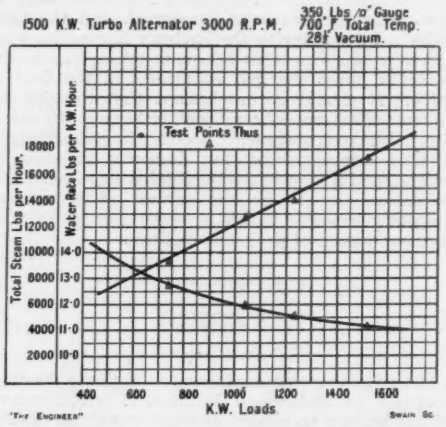
From the curves it is seen that the improvement in efficiency is greater the higher the temperature. For instance, at 175 lb. absolute pressure, an increase in temperature from 700 to 800 deg. Fah. increases the thermal efficiency nearly twice as much as does the rise in temperature of from 400 to 500 deg. Fah. The relationship of pressure and efficiency is also readily observed ; for instance, the same efficiency is obtained with steam at 300 lb. pressure and 500 deg. Fah. temperature as at 175 lb. pressure and 800 deg. Fah. temperature. The highest permissible safe working temperature of steam is about 800 deg. Fah. as applied to ordinary boiler piping and turbine material now in use. With the temperature limit thus given, higher economy can only be obtained by increasing the pressure.

When the experimental plant at Rugby was decided upon, it was hoped that a pressure of 500 lb. could be used. After consultation with Messrs. Babcock and Wilcox a compromise pressure of 350 lb. was decided upon, the steam to be superheated to a total temperature of 700 deg. Fah. The capacity of the boiler was to be 18,000 lb. of steam per hour, and the type selected was the makers' well-known self-contained marine type, with boiler, superheater, and economiser sections inside one casing, and fitted with chain grate stoker and induced draught. The turbine, which is of the impulse type, was built to standard design modified to suit the new conditions. The generator is totally closed, and the air used for cooling is delivered to the boiler grate. The plant auxiliaries call for no special comment. The plant was first put into service at the end of 1914. Steam consumption tests have been taken, and the results are given on the curve below ; the figures obtained include generator losses and excitation, but do not include power for the auxiliaries.

It should be stated that with a turbine designed specially for these high steam conditions, an improvement in the steam consumption at full load of about .4 lb. per kilowatt hour can be obtained, but this was not possible with the present machine, because as stated above, such standard parts as were available in 1913 were used in its construction. Tests on the boiler show an efficiency varying from 80 to 83 per cent. To ascertain the actual consumption of coal per kilowatt hour a ten-hour test was taken, which gave 1.83 lb. of coal per unit generated, the vacuum obtainable being but 27.7in. The average heat value of the coal as fired was 10,985 B.Th.U's per lb., or the equivalent to 20,000 B.Th.U.'s per unit generated. The mean heat value of the coal was ascertained from three average samples, tested by three independent laboratories, all agreeing very closely. The above coal consumption refers to the turbo-generator unit only, and does not include the power taken for auxiliaries, which could not be properly estimated, the circulating pump also supplying other condensers.



EFFECT OF PRESSURE AND TEMPERATURE ON EFFICIENCY



STEAM TEST OF EXTRA HIGH PRESSURE TURBINE

The new plant proved so successful and economical that it was put in commercial operation on the power circuit for the works.

The saving in coal has exceeded the 15 to 18 per cent. already mentioned, owing to the improved efficiency of the new plant under the constantly varying load and power conditions in a large works, though the older power plant is of comparatively modern construction. Only minor troubles have been met with either in turbine or boiler. Some parts were found unsuitable for the high temperature, and had to be renewed, but these have been of minor character, and have not interfered with the operation of the plant, and it may be stated that the turbine and boiler have passed out of the experimental stage. The plant was opened up and examined during the last Christmas holidays and found in good condition. As only three days were available, the inspection could not be as thorough as desired, and the plant will be again inspected during the present month, when time will permit of a more careful examination. Should anything of interest be found, or faults discovered which will alter the writer's present opinion, he would like the hospitality of your columns to return to this subject.

The writer recently had occasion to look into a large power plant scheme with favourable load factor, and found that with a boiler pressure of 350 lb., steam temperature 750 deg. F., circulating water temperature 55 deg. Fah., the heat consumption per kilowatt hour generated works out at 15,000 B.Th.U.'s, which includes a boiler efficiency of 80 per cent., all losses in turbo-generator, but does not include power for auxiliaries. Allowing 6½ per cent. for the auxiliaries the gross heat consumption per unit generated will be about 16,000 B.Th.U.'s.

Mr. Robertson, in his paper, anticipates a coal consumption of 1.45 lb. per unit sold, and with a good quantity of coal this seems to be well within the possibilities of the art to-day.

FREDERICK SAMUELSON.

Rugby, July 10th.

COAL ECONOMY.

SIR,—In your Random Reflections in last week's issue of THE ENGINEER, reference was made to the above subject, and many of your readers will agree with what you inferred, that the ultimate in coal economy will be reached by gasifying all fuel on account of the by-products, and stoking our boilers with gas, or coke and gas. Between the ultimate, which to attain will take many years and cost much money, and the general practice in vogue to-day, runs a deep channel which carries away practically fifty million tons of coal per year, our burnt offering to the twin goddesses, Indifference and Ignorance. As one who has handled steam plant for many years, I would suggest our duty is to improve present conditions. The means to effect the above

saving—the practice of common sense—could be in operation over the whole kingdom in two or three weeks, and the results would be of the greatest assistance to the Research Committee now sitting.

To save fifty million tons of coal per year would liberate approximately 150,000 men, and would remove daily from our railways 15,000 wagons and their complement of locomotives, thereby minimising the present congestion, and, apart from many other benefits, would effect a direct saving of over seventy million pounds per year.

The primary cause of our present coal wastage is our disregard of the fact that air is just as essential in producing heat as coal, and as the temperature of perfect combustion is constant, but too high for practical purposes such as steam raising, so will the temperature of our furnaces be constant when we arrange to give to our fires only the excess air required for good practical combustion.

The general practice in the boiler-house is an allowance of 25 lb. to 30 lb. of air per lb. of coal, the resulting temperature being about 1700 degrees, the evaporation per lb. of coal probably 7 lb. to 8 lb., the boiler efficiency not more than 60 per cent. That this is not a picture of fancy may be proved by the fact that the average efficiency of 100 steam plants, taken haphazard and in different parts of the country, was only a fraction over this figure. If, instead of the above weight of air, we only use 15 lb. per lb. of coal, the furnace temperature will be over 2500 degrees, the evaporation per lb. of coal over 9 lb., the boiler efficiency not far short of 80 per cent. With 15 lb. of air per lb. of coal, the loss through excess air is only 4 per cent. With 20 lb. of air it increases to 7 per cent.; with 25 lb. of air 12 per cent., and with 30 lb. of air the loss is a little over 15 per cent., the difference in temperature between the two extreme points being 1350 degrees.

The rates of radiation between two furnaces, one fed with a ratio of coal and air 1 to 15, and the other 1 to 30, is as 3 is to 1. In other words, one square foot of fire surface, when fed with air and coal at a ratio of 15 to 1, does as much work as 3ft. of fire surface with a ratio of 30 to 1; or, if the air supply was 25 lb., 3 square feet of grate would only be equal to 2 square feet with a ratio of 15 to 1. The furnace is the key to the duty and efficiency of any steam boiler, but the power to use the key is a suitable draught, and my own experience fully agrees with that of many other engineers who have studied the subject, that not more than 2 square feet of grate should be given to each square foot of outlet from the rear end of the furnace flues. The ratio of grate area to that of outlet, though it plays such an important part in the work of a boiler, does not appear to have received any attention by boilermakers, insurance companies, or others, as there is no uniformity in this direction between boilers of varying diameters.

As an illustration the outlet areas from the furnace flues of a 7ft. diameter Lancashire boiler is 8½ square feet, and the grate area, following the rule given above, should be 17 square feet, or 3ft. long, just half the standard length. In a 9ft. diameter boiler, area of outlet from furnace flues 17 square feet, the grate area should therefore be 34 square feet, the length being 4ft. instead of 6ft. In general practice the boilers given above, if exhausting their gases into the same chimney, 2½ square feet of grate in the larger boiler would burn as much coal as 4 square feet in the smaller one; but to fit them with grates of the sizes mentioned, each square foot would burn the same weight of coal.

By adopting the lines indicated in our own boiler, which is 8ft. diameter, we have reduced the length of the grates from 6ft. to 3ft. 3in., and reduced the weight of coal burned 2 tons per week. One of our clients has reduced the grates of a boiler 8ft. diameter from 6ft. to 3ft., and is now producing all the steam required to drive an engine developing over 500 horse-power, which equals 25 horse-power per square foot of grate. In another case, the grates of a boiler 8ft. 6in. diameter were reduced in length from 6ft. to 4ft., and a saving of over 150 tons of coal per year was effected.

In conclusion, as the temperature of combustion is constant, with the correct supply of excess air, the working temperature will be also constant, and as the fire-grates and outlets have a constant ratio, and are operated on by a constant draught, there is no reason outside sheer cussedness for continuing the waste of coal mentioned.

Bradford, July 4th. W. H. CASMEY.

THE WHEELS OF TRACTORS.

SIR,—It is interesting to note that the Local Government Board have found it necessary to pass a special order for the period of the war, legalising the shape of wheel of the various agricultural tractors that are now being imported into this country.

I have always considered, from the start, that the ordinary Local Government Board regulations in reference to road locomotives were regulations framed in the true interest of both the road users and ratepayers, and therefore, whilst the relaxation of these regulations at the present time, owing to the importance of getting a maximum number of tractors into use, seems necessary, it is to be hoped that after the war the old regulations will again come into force, with possibly two alterations:—

(1) That the weight resting upon a given wheel width might quite well be reduced and made more in favour of the road authorities, without in any way being detrimental to the makers or users of agricultural tractors.

(2) The minimum width of wheel allowed, I think, should be reconsidered, because the framers of the original Act had in mind engines of some 10 tons in weight. It is quite obvious that light agricultural tractors of, say, 1½ to 2½ tons in weight, should not be compelled to use the same minimum width of wheel as a 10 or 15-ton engine, but in no case need this minimum width bear even half as much weight as the original Act provided.

Since 1902 I have tried every form of grip and tread that I could conceive, and I have found nothing so good as the regulation strakes already permitted by the authorities, but I do think that the Local Government Board might reconsider the question of the minimum width of wheel for these light machines. I especially allude to the band on the front wheel. I think that if a 10 or 15-ton engine may use a band on the front wheel 5in. wide, that an engine, say, one-sixth in weight might use a band 2in. wide. This band is very useful on an agricultural tractor. It never marks the road owing to the light weight upon it, and when in the field it cuts into the soil—until the broader wheel supports the remainder of the weight—and prevents side slipping. There is no suction from these straked metal wheels as is the case with rubber-tired road lorries, and in roads where they are continually used I have always found them improve the road instead of injuring it. Their broad wheels and their light weight are insufficient to crush the metal, and they have the effect of rolling it in.

Bedford, July 4th. H. P. SAUNDERSON.

COMMERCIAL AERONAUTICS.

SIR,—Our attention has been called to the report of Mr. Holt Thomas' lecture on the subject of "Commercial Aeronautics," contained in your issue of June 8th, in which you speak of "The Aircraft Manufacturing Company, now turning out the Handley Page machine, one of the latest examples of which we illustrate." May we point out that all the Handley Page machines are designed and built exclusively by us.

As the particular machine in question, viz., one of our twin tractor biplanes fitted with two 300 horse-power Rolls Royce engines, is the only large aeroplane in this country carrying great loads, films were taken of it in flight to illustrate its particular adaptability for commercial work after the war. These were the ones exhibited at the lecture referred to.

We would point out that these machines hold all the world's records for speed, distance, duration and height from pilot and six passengers up to pilot and twenty passengers. In the latter case the pilot and twenty passengers—of a total weight of 3200 lb.—were carried to a height of 7180ft., Mr. Clifford B. Prodger being the pilot.

For and on behalf of HANDLEY PAGE, LIMITED,
J. HANDLEY, Managing Director.

London, July 4th.

CATALOGUES.

S. G. LEACH AND CO., Limited, London.—List L.F.7. Illustrated and descriptive price list of exhaust fans.

J. DAMPNEY AND CO., Limited, Cardiff.—Small descriptive pamphlet dealing with Apexior Compound No. 3, for use as a priming coat on the bottoms of ships.

ED. BENNIS AND CO., Limited, Little Hulton, Bolton.—Illustrated pamphlet descriptive of various installations of boiler-house elevators erected by the firm.

JOHN H. WILSON and Co., Limited, of Birkenhead.—Illustrated descriptive catalogues dealing with (*a*) numerous types of jib cranes, and (*b*) winches, windlasses, &c.

DONOVAN AND CO., Birmingham.—List No. T 1617, giving special net trade prices of adaptors, electric bells, bell wire, mining bells and tappers, battery material, bell pushes, wood blocks, brackets, and cut-outs.

THE BRITISH THOMSON-HOUSTON COMPANY, Limited, London.—Price list No. 10,550 A. Illustrated descriptive pamphlet dealing with the B.T.H. "Eye-Rest" System of Illumination from Concealed Sources employing "X-ray" Reflectors.

THE General Electric Company, Limited, Witton, Birmingham.—Illustrated descriptive leaflets:—No. L 2093, "G.E.C. Haulage Road Signalling in Collieries"; O 2104, "The Kingsway Miners' Electric Hand Lamp"; and V 2088, "'Witton' Moulded Insulation Terminal Blocks."

THE LIGHT ELECTRIC MOTOR COMPANY, Dundee.—Illustrated, descriptive, and priced leaflets: A and B, Portable Electric Drilling Machines; C, the "Dundee" Electric Grinder; D, the "Dundee" Electric Grinder with screw feed attachment; E, the "Dundee" Electric Grinder for internal grinding; F, Portable Electric Drilling Machines, heavy duty, side-spindle type; G, Portable Motor-driven Pump; and H, Portable Electric Grinding and Polishing Machine.

ATELIERS DE CONSTRUCTION OERLIKON (Switzerland). London Office: Oswaldestre House, Norfolk-street, Strand, W.C. 2.—"Some Oerlikon Specialities." A well got up and illustrated brochure, showing numerous examples of the products of this firm. "Communications Périodiques": No. 85, High Frequency Machines; No. 87, Safety Devices for Steam Turbines; No. 88, Rheostatic Brakes for Hoisting Machinery. Illustrated descriptive pamphlets in French.

IGRANIC ELECTRIC COMPANY.—Portfolio of illustrated price lists, giving descriptions of many types of electric switches and controlling devices manufactured by this firm. The portfolio is not complete, it being the intention of the firm to add further sheets, which can readily be inserted with the others, the idea being to make the catalogue the most complete list of electric controlling apparatus ever compiled. The sheets already issued are certainly excellently got up.

TURNER BROTHERS ASBESTOS COMPANY, Limited, Rochdale.—This is a tastefully produced catalogue dealing with asbestos fibre, yarn, cloth, webbing, tubing, listing, packings and jointing. Turner Brothers claim to have occupied a conspicuous place among the pioneers of the industry, and to have originated many of the standard articles of the trade. The number of uses to which asbestos is applied as a packing in engineering work is well illustrated in this publication, beginning with the ordinary plaited variety to those for ammonia and acid pumps and superheated steam. The catalogue contains several pages of information useful to engineers.

THE British Westinghouse Electric and Manufacturing Company, Limited. Illustrated leaflets: No. 301/1, "H.T. and L.T. Switchgear"; No. 301/2, "Substation Switchboard"; No. 301/3, "Low-tension Switchboard"; No. 301/4, "'Remote Control' Electrically-operated, Type H., Oil Switch Equipment, 11,000 volts"—all at the London and North-Western Railway Company's Power Station, Stonebridge Park; No. 301/5, "Substation Switchboard"; and No. 301/6, "Substation Switchgear," both at the Willesden Substation of the same company; No. 301/7, "Substation Switchgear," at the Dalston Substation of the same company; No. 301/8, "35,000-volt A.C. Switchgear Equipment at the Works of Det Norske Nitridaktieselskap"; No. 301/9, "Low-tension Switchgear at the Clydebank Works of the Singer Manufacturing Company, Limited; and No. 301/10, "Sheet Steel Cubicle Type Substation Switchgear at the Wolverhampton-street Substation of the Walsall Corporation." This firm, we may add, has also recently issued three pamphlets, Nos. 7855/2, 7855/3, 7855/4, written by Mr. F. Walker. The subjects dealt with are: "The Choice of Motors for Industrial Work." "Contactor Control Gear for use with Electric Motors in Industrial Work." and "The Control of Motors for Industrial Work." Although the pamphlets are, of course, published primarily for advertising purposes, Mr. Walker has stated the case for the different types of machines in an impartial manner, and his remarks in the main on the choice of motors will apply equally to the manufactures of other firms. Being written obviously for the enlightenment of users rather than for expert electricians, the illustrations and descriptive matter will convey just that information in a compact form in a manner which should prove particularly acceptable. For instance, the characteristic features of shunt-wound, series-wound, and compound-wound motors of the direct-current type, and the class of work for which they are specially adapted, are very clearly set forth, as are those of the different kinds for alternating currents.

THE SOCIETY OF ENGINEERS.—On the 20th June, the President of the Society of Engineers, together with several Fellows and members, attended a demonstration of the working of the machinery of the Goods Clearing House, which was held at the New Transport Company's Works at Ingate-place, Battersea. This visit was the outcome of a paper, entitled "The Goods Clearing House System and Machinery Explained," and read before the Society by a member of Council on May 7th last. It was felt that the practical demonstration of the working of full-sized "truckers," electrically controlled, and actuated by electro-magnetic power, would afford opportunities for inquiry and explanation, impossible even in an illustrated lecture. Mr. A. W. Gattie, the inventor, conducted the demonstration, and there were present many important representatives of various trades as well as scientific men in all branches of engineering. Very general satisfaction was felt at the completeness of the system, and the smooth working of the magnetically controlled sorting trays as they were transferred from platform to platform of the moving truckers passing one another at different speeds. Tea was served soon after four o'clock, and the President of the Society, Mr. Henry C. Adams, thanked Mr. Gattie and the directors of the New Transport Company, in the name of the Society, for the opportunity they had had of witnessing the actual working of the very remarkable machinery.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Midland Iron Trade Quarterly Meeting.

THE business now negotiated on the Birmingham Iron Exchange represents only a small proportion of the aggregate being done in the entire Midlands district. With increasing stringency in various departments there is less and less scope for merchants, and these once important accessories to buying and selling in the iron and steel trades are steadily being squeezed out of recognition. Evident as this circumstance is week by week on the iron market here, it was much emphasised at the July quarterly meeting of the Midland iron trade held in Birmingham to-day—Thursday. Nearly all the output of iron and steel is going into consumption. With the best endeavours that can be put forward mills and forges cannot keep up with the productive capacity of the works that look to them for raw materials. Efforts have been made to place business into 1918, but generally without effect. Most of the works are refusing much more business than they can possibly accept. Government orders, in particular, are abundant. No reliable information was forthcoming to-day as to the intentions of the bar iron houses regarding a possible increase in maximum prices. A resolution has been passed by certain Staffordshire makers in favour of promoting an application to the Ministry of Munitions for better terms, on the ground of increasing cost of production. The matter was indeed raised prior to the recent advance of South Staffordshire part-mine pig iron prices of 5s. per ton, and it is urged the latter development strengthens the claim. Whether any further steps will be taken depends apparently on the decision of the very important committee formed last year in connection with the movement for consolidating the British manufactured iron trade along national lines.

Finished Iron Prices.

Finished iron prices to-day were:—Marked bars, £15 10s., less 2½ per cent. (Earl of Dudley's brand £16 2s. 6d.); unmarked bars, £13 15s.; North Staffordshire bars, £13 15s.; steel joists and sections, £11 2s. 6d. All the above are the maximum prices prescribed f.o.t. at makers' works net, except in case of marked bars. Uncontrolled prices were—Gas strip, £15 5s. to £15 10s.; hoops (iron and steel), £18 and upwards; and black sheets, doubles, £19 10s. Nut and bolt manufacturers have to pay from £14 5s. to £14 11s. 3d. for supplies of bars delivered in the Black Country. Puddled bars make about £12 5s., but they are not only to be obtained by private negotiation, as producers have but a few left over for regular customers after satisfying their own requirements. Small rounds cannot be bought at less than £16 15s. ¾in. basis.

Pig Iron Trade.

Pig iron at to-day's (Thursday's) quarterly meeting in Birmingham was very active. South Staffordshire smelters could have sold much more than they can produce at the full 5s. per ton increase lately authorised. Foundry sorts were in urgent request. Other district makes were also called for in larger volume than a month or two ago. Smelters are compelled to take precautions against getting over-sold. Some customers are doubling their orders, but in these circumstances they get only a very limited guarantee as to delivery. The blast-furnaces, which for a time were able to supply more than the requirements in common forge and foundry irons, are now experiencing the full strains of an accelerated demand. The demand for basic iron as a paramount necessity of the situation has done something to hasten the stringency in forge and foundry irons. Furnace owners have sold a good deal of their output over the next three months. The absence of any reply from the Ministry of Munitions as to the application of Derbyshire and Northamptonshire smelters for increased maximum prices is now taken to signify refusal. All current business is at the full rates. South Staffordshire houses find no difficulty in obtaining all the increase which the Ministry of Munitions has officially given consent to. Selling prices at the quarterly meeting were as here:—South Staffordshire—Common forge iron, 95s.; part-mine forge, 100s.; foundry, 102s. 6d.; all-mine forge, 115s.; foundry, 120s.; warm air forge, 145s.; foundry, 155s.; special quality (Lord Dudley's cylinder), 167s. 6d.; cold blast, 182s. 6d. North Staffordshire: No. 4 forge, 95s.; foundry numbers, 97s. 6d.; basic, 97s. 6d. Northamptonshire: No. 4 forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry 94s.; basic, 97s. 6d. Derbyshire: No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; No. 2 foundry, 94s. 6d.; No. 1 foundry, 96s. 6d.; basic, 97s. 6d.

Steel Trade.

Pressure is as heavy as ever in the steel works. It is stated some of the mills are being taken off shell bars and put on plates for the mercantile marine. A little business is being done in steel strip at £17 10s., but some makers will not entertain £18. Steel rounds make £17 10s. The price of American wire rods continues to appreciate, and is now nearly £30 per ton. Greater regularity prevails as regards shipping facilities.

LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THERE is very little alteration in the general condition of the iron and steel markets here, but some change seems to be taking place in other districts, which may have a bearing upon the Lancashire markets later on. It is particularly noticeable, for instance, that, while the demand for the common qualities of iron is more than equal to the supplies in the Midland districts, it is certainly

below the current supply in the North-Eastern districts; and one is a little puzzled to account for this. There seems to be no doubt about the fact, for the indifference of consumers in those districts to future supplies is evidence that they are under no anxiety; and besides this there has been a tendency to shade the maximum prices. This tendency is quite apparent in connection with forge iron, and is latent in connection with foundry. It is true that makers claim that the maxima do not leave more than a small margin of profit, but this claim must be taken with a grain of salt. I have never known a time when pig iron was produced at an adequate profit from the point of view of the ironmaster. Judging from a long experience it would appear, if one based one's estimate upon furnace owners' views, that pig iron is always made at a loss. Hence I do not think that the mere fact of there being no profit in the opinion of the maker could alone keep the prices up; and, in fact, I have never known it to do so. The point for Lancashire consumers is, of course, that if the regular markets for North-Eastern iron are insufficient some of the iron will have to be sold elsewhere, and the question is where? There is also another point, for if Cleveland ironmasters desire to press sales of their product they will also desire to get rid of that absurd and unfair "Cleveland certificate" which stands in the way of merchant business. It is not at all probable that all the ironmasters in the district approved of the certificate at the beginning, but more probable that some of them were over-ruled, or perhaps did not at first realise its sinister significance. It would be worth a slump in Cleveland iron to clear this silly document out of the way.

Foundry Iron.

The Manchester market for foundry iron is rather quieter than it was, and there seems a tendency to slackness in the demand; but while the supply is limited to what Derbyshire furnaces can spare, supplemented by a little North Staffordshire iron at a higher price, there can be no anxiety on the part of sellers. The foundryman's trade here, even if quiet, is undoubtedly equal to the consumption of any iron likely to be offered from these two sources. What would happen if any other foundry iron, such as Cleveland, were pressed for sale in this market it is difficult to say, but there might then be some serious competition for orders which would put some life and interest into the trade. It is a little curious to hear merchants complaining of the lack of interest simply because they do not have to work hard in the competition for business. There is no change in the position as regards Scotch iron, which sells in small quantities as a rule at the full maximum rates. Eglinton and Monkland irons, commonly sold here in the largest lots, are, however, seldom heard of now, and Clyde and Summerlee take their place, although these are a dearer class of iron. Glengarnock is, of course, still in evidence.

Forge Iron.

The demand for forge quality of pig iron is poor, but the price is firm at the full maximum.

Steel.

There are no offers of semi-steel at any price, and one must suppose that importers have given up the hope of business. Very occasionally a lot of wire rods is mentioned, and it is to be presumed that there are some consumers who must have the material at any price, and who thus are made to pay £30 per ton for it. Of finished steel one now hears nothing in the open market.

Scrap.

A curious dulness has come over the trade in ordinary heavy steel scrap, and business here seems to have stopped for the present. It is some weeks since consumers in the North-Eastern district made inquiries for Lancashire scrap, and now it would appear that South Wales is off the market. This abstention cannot well last for any length of time in the present condition of the steel trade, but it may give occasion for some accumulation of stocks here. The price remains at the full maximum, viz., 105s. on trucks, and holders are not pressing sales or offering to make any concessions, nor are they likely to do so unless the dulness should last much longer, when perhaps it might be necessary to clear stocks. The feeling in the trade is that the fixed price is quite low enough. There are buyers of steel turnings at the maximum of 50s. on trucks, but this is because the material is cheap. Apparently those who have good heavy turnings are holding out for more money, but whether they can legitimately get more is a doubtful point. Possibly some way of overcoming the difficulty will be found when both buyers and sellers are agreed that the price ought to be raised. Wrought scrap is not offered at all in this market, although numerous inquiries for it are coming in. The position calls urgently for revision, as consumers can well afford to pay a higher price, and many of them are quite anxious to do so. I hear of offers at higher prices made subject to the consumer taking all the risk of breaking the regulations; but to my mind the seller would not be able to divest himself of his responsibility in this manner whatever the details of the arrangement entered into. It is obvious that something should be done quickly to regularise the position. The demand for foundry scrap is rather quiet, but dealers maintain their prices, and as the quantity coming into the market is still only moderate it is probable that they can wait a good while before there will be any necessity to offer concessions. For the finest textile scrap 112s. 6d. to 115s. per ton is asked, delivered free to a buyer's station. For other qualities 105s. to 110s.

Metals.

There has been very little change in the metal situation during the week. English ingot tin is offered here by merchants at £250 per ton delivered. Lead is not quoted. Strong copper sheets remain at £165. Tin is really the only metal in which any interest can be taken, for the others certainly do not pay to handle.

Engineers and Research Work.

A short time ago I referred in this column to a movement which had been set on foot in this district amongst practical engineers to form a local organisation for carrying out research work in connection with matters of general engineering interest. The movement was started by a few enterprising men who felt the necessity for conducting this class of work with a view to benefiting manufacturing engineers who had not the means to carry out such work in their own workshops. I understand that at a meeting of the British Engineers' Association held at the Engineers' Club last week, it was decided that the Association should assist this branch of work, and that it should be undertaken by the Class C members, *i.e.*, individual engineers or persons intimately connected with the engineering industry.

The Tramways Strike Ended.

Lancashire is earning for itself an unenviable reputation as regards labour troubles. The recent engineering dispute, which did so much to interfere with the flow of necessary warlike material to the fighting forces—*vide* the Prime Minister in the House of Commons on Monday last—has been followed by a peculiar and very unfair kind of "stay-in" strike on the part of the Manchester Corporation tramway workers. Being dissatisfied with the grant of 2s. 6d. per week, the drivers and male conductors demanded a war bonus of 10s. per week, and the women conductors an additional 7s. per week. Instead of quitting their work, however, the workers adopted a "dog-in-the-manger" attitude, by continuing their employment but refusing to work more than the minimum number of hours, thus stopping all overtime, for which they were paid extra, and also refusing to allow more passengers on the cars than the legal load. It was in the latter connection that the greatest inconvenience was caused to the travelling public, for the former restrictions on the number of persons carried by the vehicles have been withdrawn for some time owing to the reduction in the number of workers available to work the cars. A good deal of friction has been caused owing to the attitude taken by the conductors, and had these not been chiefly females in many cases they would have been roughly handled. However, normal conditions have now been resumed owing to the offer of the Ministry of Labour to "arrange for the difficulties that have arisen since the last award was made to be submitted to arbitration within seven days, and the decision to be announced within fourteen days."

Another Strike Averted.

Owing to the demand of the enginemen and firemen in the cotton mills and workshops of Burnley, Brierfield, Nelson, Colne, Padiham, and Accrington for an increase of 12s. per week in their wages, a stoppage of the mills in these districts seemed imminent a few days ago. The trouble has been temporarily averted, however, by the men's acceptance of an offer of 9s. per week, on condition that the question of a higher advance be left to an arbitrator to be appointed by Sir George Askwith.

BARROW-IN-FURNESS, Thursday.

Hematites.

Throughout this district there is marked activity in the hematite pig iron trade. In all there are thirty furnaces in blast, and the whole of the output is going into prompt use. At Barrow and at Workington steel makers take a big tonnage of metal all the time, and the iron is conveyed direct from the furnaces to the steel converters. Other local users have considerable requirements. Outside users are urgent in their demand for iron, and a much more liberal output could be easily disposed of. It was expected that additional men would by this time have been at work in the mines, but the number has not as yet increased to any extent. The huts at Askam and Millom in which these miners will live are now ready for their occupation, and at any time the dwellings may be occupied. Prices of iron are steady at the maximum rates of 127s. 6d. per ton, and special brands are at 140s. per ton f.o.t.

Iron Ore.

The demand for hematite iron ore is very strong. Local smelters have big requirements, and could readily account for the whole of the ore raised—in fact, do so already, but not a deal is being sent out of the district. Foreign ores are in steady request.

Steel.

There is a busy state of affairs at the two steel centres, Barrow and Workington. Makers are experiencing a very full demand for their output, which is largely confined to billets and semi-manufactured sorts generally, although some rails have been rolled at Barrow on a special order. Ordinary commercial business is in the background. Steel prices are unchanged, with heavy rails at £10 17s. 6d. to £11 10s.; light rails, £14 to £14 10s.; heavy tram rails, £14; billets, £12; ship plates, £11 10s.; and boiler plates, £12 10s. per ton. Engineers are very busily employed, as are iron and steel founders and those engaged in speciality trades.

Fuel.

For coal there is a brisk demand, with good steam sorts at 25s. to 27s. 6d. per ton, and house coal is at 27s. 6d. to 37s. 6d. per ton, delivered. For coke the demand is full of life, and East Coast qualities are at 33s. to 35s. 6d. per ton, delivered; and Lancashire cokes are at 31s. per ton, delivered.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

A STEADY but quiet business is being done on the Cleveland pig iron market. The trade position is exceedingly strong. The furnaces have been working particularly well notwithstanding the prolonged strain, and as a result an excellent proportion of the better qualities has been forthcoming. The proportion of forge iron produced is less than it has been, while, on the other hand, substantial quantities have been taken up for the finished iron industries. Thus the amount of stock in hand has diminished. A few belated July allocations have just been dealt with, but business at the moment is quiet, as none of the foundries are pressing for deliveries, while the forward position is neglected. The export position is more satisfactory. With tonnage more plentiful supplies to France have improved, and the exports to Italy are also likely to be better. Quotations are unaltered, the maximum home price for No. 3, No. 4 foundry, and No. 4 forge being 92s. 6d., with a premium of 4s. for No. 1. The export quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

Considerable activity prevails in the hematite pig iron trade. The allocations to home consumers continue to be satisfactory, although the accumulation of any stocks is out of the question. Allotments to the Allies are expected in a few days, and it is understood they will be rather better than some traders had anticipated. Italian consumers are putting forward a very heavy inquiry. Present export quotations are purely nominal at 137s. 6d. for France, and 142s. 6d. for Italy. The home maximum price is 122s. 6d. for East Coast mixed numbers.

Iron-making Materials.

Foreign ore supplies are coming forward rather better; coke is steady at current rates, good medium furnace kinds being about 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

Nothing could exceed the present activity in the manufactured iron and steel trades on the North-East Coast. The demand for all descriptions for war purposes and the shipyards is more intense than ever, and manufacturers have no small difficulty in coping with the necessary requirements, even though the mills are working at their maximum capacity. The increasing requirements of the Government have made further restrictions necessary, with the result that less material can be set aside for the ordinary home or export trade, only shell discard steel being available for those purposes. Recent activities of the shipping Controller and those associated with him in the building and equipping of vessels have greatly added to the pressure in steel-making plants. In the finished iron trade makers are fully employed alike in their iron and steel departments. While general business is greatly restricted there remains an ample sufficiency of Government orders to keep things moving at high pressure for a considerable period ahead, practically the whole of the output being absorbed. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ¾in. and upwards, £13 10s.; $^{5}/_{16}$in., £13 15s.; ¼in., £14; $^{3}/_{16}$in. £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles, and joists, packing iron and iron bars.

Shipbuilding and Engineering.

There is more and more activity in these trades, a good many additional men having been imported into the district during the past few weeks. The rapidity with which some of the work is being executed is really remarkable.

Transport of Coal Scheme.

The scheme of the Coal Controller for economising the transport of coal and its more equitable distribution, which comes into operation from September 10th, is of a drastic character, but colliery interests have not, of course, been taken by surprise in any sense. They have known for some little time what to expect, and have been simply waiting for the official announcement. In future all need of seeking coal or customers will be obviated. The scheme does not apply to water-borne coal; but as regards inland consumption of coal taken by rail the rule will be made that coal shall be drawn for consumption exclusively from the nearest producing point; that the traffic shall be chiefly along main trunk lines, and that coal movements shall, as far as possible, be from North to South, from North to South-East, from North to South-West, and from East to West. Thus into an area producing coal sufficient for its purpose, as in the case of Northumberland and Durham, none will be imported from any other area. An area producing more coal than it requires for its own consumption will distribute the balance to adjacent or convenient areas. It will be remembered that the Board of Trade in the time of the late Government appointed district Coal and Coke Committees, and these bodies with some additions will have the working of the new scheme. Obviously where coal is produced and consumed in the same area there will be no occasion for the disturbance of contracts. But where contracts have been made involving a long hauling, the contracts will have to be abrogated.

The Coal Market.

Highly sensitive to the slightest change in conditions the coal market is naturally in an uncertain state owing to the new orders of the Coal Controller. A considerable amount of business is held up by merchants hesitating until many points in the new orders are cleared up, and on these questions merchants are particularly eager to get a definition. Meantime, transactions are

chiefly confined to higher priced coals, which are not affected to any great extent by the Control Order. Special Wear gas coal is mainly sought after, and transactions have been recorded at 30s., although some sellers ask even higher figures. Tyne prime gas coals also find an appreciable market at 25s., but against this is a pronounced slackness for second gas coals which meet little encouragement at 23s. 6d. In the Northumberland section favourite qualities of steams are wanted in excess of the output. A good steady tone is also the dominating factor in second steams; but, on the other hand, second smalls are abundant and nominal in value. Durham manufacturing coals, such as smithies, peas, nuts, and similar are in full demand for inland consumption. Coking coals for export are not pressed for sale, while bunker coals are in steady demand. Quotations are as follows :—Northumberlands : Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d to 27s.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade ; 28s. 6d. to 30s. for export ; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. 6d.; North Northumberland smalls, 20s.; seconds, 18s. 6d. Durhams : Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; best, 25s.; superior, 30s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

Blast-furnacemen's Wages Advanced.

Another substantial advance in wages has been conceded to blast-furnacemen under the sliding scale arrangement. The average net selling price of No. 3 Cleveland pig iron for the past quarter is certified at 94s. 4.91d. per ton, an advance of 4s. 8.15d. per ton on the price for the previous quarter. This means an advance in blast-furnacemen's wages of 6 per cent., which will raise the wages from 72 to 78 per cent. above the standard.

Cleveland Miners' Wages.

A conference took place at Middlesbrough, on Monday, between the Cleveland Mine Owners' and Miners' representatives on the subject of the wages to be paid during the ensuing three months. It was agreed that the present district percentage of 95.25 should be converted into 105 per cent. inclusive of war bonus, which at the mines is paid in the form of percentage. The base rate before the outbreak of war stood at 29½ per cent. They have thus, in less than three years, had rises which are equivalent to 75 per cent.

SCOTLAND.

(From our own Correspondent.)

The Holiday Season.

THE holiday season has not been interfered with this year, and the local "fair" holidays in Glasgow and district commence to-day and last until Monday, 23rd July. The closure will be general, the work only being kept open in order to make necessary alterations and repairs. Consequently, a special effort is being made to reach a substantial increase in outputs and thereby create an appreciable impression on arrears.

The Position of the Merchant.

The position of the merchant or "middleman" has become a most unenviable one, and it is questionable if present-day circumstances render it worth while to continue in such a capacity. The restrictions governing all classes of material, both as regards disposal and price, have completely revolutionised the mode of doing business, and direct dealing is now the order of the day. For instance, if anyone, either in the ordinary course of business or privately, has any metal to dispose of all that is required is to notify the Government Department interested and a notice will be returned indicating the nearest buyer. Prices are, of course, fixed, and therefore it is not worth the refiner's or the merchant's while to handle the stuff. Some firms have in all times stood out against the "middleman" principle, and the extra profits entailed, and it is a debatable point whether this mode of transacting business will ever again assume pre-war proportions.

Wages in the Electrical Trade.

Sir Richard Lodge, as arbitrator in the claim for an increase of wages to be paid in the electrical trade in the chief towns in Scotland, has issued his award as follows :—The workers employed with firms in the Electrical Contractors' Association shall receive the war advances granted by the Committee on Production to the shipbuilding trades on March 1st last. The effect of the award is that the employees receive an advance of a fraction under 1½d. per hour as from the beginning of June, which is made up of the special advance of 5s. plus 9d., being the difference between the advance of wages already obtained in the electrical trade during the war (1½d. per hour on 6s. 3d. per week), and the general advance of 7s. which by the award of the Committee on Production is presumed to have already been obtained by the employees.

Pig Iron.

Pig iron is still in heavy request. Hematite producers in particular have very little to spare, while ordinary brands are also becoming scarcer. Outputs are quickly absorbed, and everything utilised in connection with war requirements. Some small consignments are going to France and Italy.

Quotations.

Prices are firm and unchanged. Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 130s.; Nos. 3, 125s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

Conditions in the Scotch steel and iron trades are unaltered. A great effort is being made to increase outputs and to lessen arrears, but although the productive capacity of the mills continues to grow demands appear to increase in greater ratio. At the steel works the demand for shell bars is very urgent, while the amount of shipbuilding material required is extremely large, especially angles and plates. The production of heavy gauges, black sheets, is fairly satisfactory. The situation in the malleable iron trade shows little change. Everything now is for naval or military use, and domestic consumers are not getting anything like the supplies they would like to have. All descriptions of machinery are in heavy demand, and machine tool makers in particular have a large number of orders on hand both for home and abroad.

Coal.

The Scotch coal trade continues dull and inactive. The industrial demand is comparatively well maintained, but business in other directions is decidedly slow. Collieries in most cases find their outputs in excess of orders. Shipping returns are, however, somewhat larger this week, the aggregate being 161,186 tons, compared with 150,670 in the preceding week, and 218,127 tons in the corresponding week of last year. The controlled maximum prices are now in operation. Ells are quoted f.o.b. at Glasgow, 26s. to 28s.; splints, 28s. to 30s.; navigations screened, 28s. to 30s.; unscreened, 23s. 6d. to 25s.; steams, 27s. 6d., treble nuts, 23s. 6d.; doubles, 22s.; singles, 21s.; first-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s.; best steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Railway Fusion.

SINCE writing a week ago an event of outstanding importance affecting the future of Cardiff and the Bute Docks has come about with regard to control of local railways. Mr. E. A. Prosser, who is the general manager of the Rhymney Railway Company, and also of the Cardiff Railway Company, which owns the Bute Docks, has been appointed general manager of the Taff Vale Railway Company, and Mr. A. Beasley, who has been the general manager of the Taff Vale Company for about twenty-six years, has retired from this position, and has been given a seat on the Board of Directors. This highly important development has created no real surprise in local coal and shipping circles, inasmuch as when Mr. E. A. Prosser succeeded Colonel Denniss in the management of the Cardiff Railway Company, it was generally expected that the next step would be to bring in the Taff Vale Company in order that a closer and more efficient working of the railways and the Bute Docks might be achieved. As a matter of fact, for the past three months negotiations have been quietly in progress between the Taff Vale, Rhymney, and Bute authorities to establish unity in control, and a committee of six, comprising two directors from each company, has been at work. More than once the negotiations have been within an ace of completely breaking down, and it has been a task of no little magnitude to transform what have been conflicting into co-operative interests.

The Coal Trade.

The Coal Controller's scheme for dealing with the sale of coals for export has been quickly followed by the scheme in its relation to the inland distribution of supplies. Traders have not yet fully digested the former, so that the publication of the details of the latter has only served to unsettle the trade generally to an even greater extent. A considerable time must elapse before the full measure of these schemes can be appreciated. In times such as these it is a bold stroke to endeavour to revolutionise in the course of a few months what has been the growth of years of commerce, and until the schemes are well in operation it is difficult to see how they will work out. The purpose of the inland coal supply distribution scheme and its broad outlines are by this time pretty well known. So far as South Wales is concerned, Mr. Finlay A. Gibson, the secretary of the Monmouthshire and South Wales Coalowners' Association, has issued a memorandum explaining the scheme as it affects this district. The requirements of all consumers in Monmouthshire and South Wales must in the first place be satisfied before any coals can be sent by public railway to any other area, and even then only certain descriptions of coal may be sold for consumption in the specified outside areas. Steam and manufacturing coals may be sent to the South-Western and South-Eastern counties, but gas and coking coals cannot be supplied to any area outside of Monmouthshire and South Wales. House coals may be supplied to South-Western counties. All other areas are prohibited areas, and no coal of any description can be sent from South Wales and Monmouthshire to them except under a certificate from the Controller of Coal Mines. No coal from other coalfields can be imported into Monmouthshire and South Wales other than steam and manufacturing coals and house coal from Shropshire, and then only under local restrictions. The Coal and Coke Supplies Committee for South Wales will communicate with colliery companies, factors, merchants, and direct consumers with a view to obtaining from them information necessary to enable it to arrange for supplies from Monmouthshire and South Wales collieries in substitution for coals hitherto brought into this district. As is well known, by far the bulk of South Wales coal is of steam quality, and very considerable quantities of supplies for household purposes come from other areas.

Current Business.

Under the influence of the Coal Controller's scheme fixing a schedule of prices for allied destinations, the market has become thoroughly stereotyped. In fact, there is no market, inasmuch as all bargaining is done away with, and the conditions on the Coal Exchange are even duller than a few weeks ago. It is true that the official list of classified coals has not been issued and is not expected before next week; but most people know pretty well in which category certain leading coals are placed, and the price which must be paid for those coals, so that a fair amount of business has been quietly arranged. But operations are more than usually restricted, and under prevailing conditions there is no incentive or advantage in booking ahead. Certain points in the scheme are still being discussed; one matter which is being criticised being the stipulation that in the case of coals for export to neutral destinations out of the brokerage of ½ of 5 per cent. which is to be charged by the charterers only 6d. is to be retained by the merchants, and the balance is to be paid to the colliery shipping the coal. This means that on any freight exceeding 30s. per ton collieries take all the brokerage, and in the case of a cargo to Barcelona, for instance, collieries will take 2s. 6d. out of every 3s. per ton. By this means the Coal Controller will materially assist the earnings of the colliery companies and so help to make the collieries paying concerns, with the prospect of providing a substantial sum for the benefit of the Government over and above what he is guaranteed to the collieries under his compensation scheme to the owners. With regard to the schedule price of bunker coals, it is reported that all bunker smalls are to be fixed at 21s. 6d. instead of 23s. for best qualities, and 21s. 6d. for what are described as best ordinaries, but so far this is not official. It was thought at the time that the schedule was first published that 23s. for best bunkers was rather too high. Patent fuel which is not in the schedule is quoted at 30s. to 31s. 6d., and makers have been asked to consider the question of prices for supplies for inland consumption. Manufacturers fear, however, that owing to shortage of labour they will not be able to guarantee very much fuel for inland purposes. As things are, their output is only sufficient to meet their commitments to Allied countries, but in the event of tonnage shortage they might be able to spare some for home consumption. Pitwood is an easier market owing to collieries not being able to supply wagons, and prices are about 65s. to 67s. 6d., on which basis business has been done.

Schedule Prices.

Steam coal : Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; Best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal : Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d.; patent fuel, 30s. to 31s. 6d.; coke-oven coke, 47s. 6d.; pitwood, ex ship, 65s. to 67s. 6d.

LATER.

There is no change in market conditions, which are very dull. Coal supplies are plentiful, and there are numerous temporary stoppages of work. Mr. R. M. Stewart, the Secretary of the Central Executive for the Supply of Coal to France, has communicated with the Local Committee, stating with regard to the directions as to the sale of coal, that in the case of contracts made before May 1st, 1917, or purchases after that date which have been re-sold before June 28th, none of the directions applies thereto, so that the brokerage on freight in such cases belongs entirely to the merchant.

Newport.

The amount of business completed has been comparatively small, but the position of Monmouthshire collieries has slightly improved, as the result of better arrivals of tonnage last week-end, and the consequent release of wagons. Prices :—Steam coal : Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s. Bituminous coals : Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s. to 31s. 6d.; pitwood, ex ship, 65s. to 67s. 6d.

Swansea.

The tone of the market has continued to be rather depressed, as operations have been on a poor scale, and stocks of coal have been heavy. A deputation, consisting of the Managing Committee of the Swansea Harbour Trust, recently had an interview with Sir J. Maclay, the Shipping Controller, with reference to greater use being made by the Government of Swansea Harbour. The Committee was promised that its views should be given full consideration. Prices :—Anthracite : Best malting large, 30s.; second malting large, 29s.; Red Vein large, 25s. 6d.; machine made cobbles, 42s. 6d.; machine made nuts, best, 42s. 6d.; machine made nuts, seconds, 41s.; machine broken beans, best, 35s.; rubbly culm, 13s. Steam coal : Best large, 30s.; seconds, 27s.; bunkers, through, 25s.; smalls, 19s. Bituminous coal : Through, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates and Metals.

There is no material change in the tin-plate trade. The market for plates is very firm, but in view of difficult working conditions, it is hard to get quotations for business ahead. Prices rule about 36s. to 37s. a box of I.C. 14 × 20 × 112 sheets for Class A certificate plates. Quotations :—Block tin, £246 10s. per ton cash ; £242 5s. per ton three months ; copper, £130 per ton cash ; £129 10s. per ton three months. Lead : Spanish, £30 10s. per ton.

SHEFFIELD.

(From our own Correspondent.)

Steel Works Laboratories.

ONE of the ways in which the steel works in this district are preparing for trade conditions after the war is in a much closer attention to the provision of laboratories. Taking the past two months, for instance, I should think that fully half a dozen new laboratories have come into existence. It becomes a costly business to send out samples for analysis, and not always a satisfactory one, but it is a great deal more costly in the end to neglect this phase of steel production and purchase. Manufacturers with laboratories do not expect their chemists to produce steel, but they know by experience that the work done in the laboratory is not only instrumental in saving during the year the cost of the necessary equipment and staff many times over, but it enables them to know precisely the content percentage of incoming ferro-alloys, say, or the exact quality of outgoing steel. In many other ways, too, the work of laboratories is absolutely essential to up-to-date steel firms, the only wonder being that more of them have not been established. In the future the need will be even greater, for the foreign countries from which we shall have to fear the keenest competition have long ago recognised the importance of the laboratory in every works of any size at all. One of the things that has always amazed me in regard to Sheffield industries is the supreme indifference to this matter shown by the silver and electro-plating trade. Many a steel director will spend more on cigars in one year than all the silver industry put together appear to spend on laboratory work. What is the result ? All sorts of metals are liable to be palmed off on to some of these firms, who waste time wondering why a material supposed to have a certain nickel content comes to grief in the rolling. Some of the largest steel concerns here, where the value of the laboratory has been proved over and over again, and where important research work is always proceeding, are just now making very considerable extensions of these facilities. In the past the formulas of large numbers of special steels have been discovered by metallurgical chemists, one of the most recent, of course, being the stainless steel now coming in so very usefully in the manufacture of certain aeroplane parts in particular : but there is reason to believe that a great deal more will be attached, and rightly so, to this research work in future. Some of the laboratory developments are of a highly important nature, and in view of this movement the action of the responsible authorities in disturbing chemists' staffs as little as possible, even if the members of them are of military age, seems very wise. There is a great present as well as future for Sheffield steel, but it must be run upon thoroughly scientific lines.

The Help of Engineers.

That thought reminds me of the fact that the relationships of the engineering and cutlery trades are becoming very much closer. With the opening of the war the oldest branch of the Sheffield steel trade began to realise how far behind it had lagged, and now it understands that the reconstruction of the industry must be upon the basis of machinery practice, almost wholly discarding the handicraft methods upon which the reputation of Sheffield cutlery has in the past so greatly depended. But there is one rock that may cause trouble if it is not carefully avoided by even up-to-date cutlery manufacturers, and that is trying to run machinery with no engineers, or at best perhaps one to a factory. If value is to be obtained for capital sunk in machinery it will not be by any cheese-paring policy such as that. Good machinery requires the constant attention of efficient engineers, and money so invested will, in its way, bring as good results in the end as expenditure upon the maintenance of a steel works laboratory. Just now, of course, it is difficult to secure any skilled labour. You might almost as well cry for the moon. But we are three years nearer the end of the war, and when that blessed time comes a stronger link than ever between the heavy tool and cutlery branches of the Sheffield steel industry should be forged by the introduction into the last-named of a strong engineering element. I have heard of a German cutlery works, equipped with machinery and employing 500 persons, having an engineering staff of fifty. Such a proportion may take away the breath of some quite advanced Sheffield firms, but their German rival finds that it pays, and that, after all, is the practical gauge. Moreover, a suggestion that I made some little time ago, that facilities might be afforded, perhaps, at the Applied Science Department of the Sheffield University for training the more intelligent and ambitious cutlery workers in the use of machinery, met with an immediate response from a number of those workers eager to be afforded such help. I do not know that the University authorities have yet seen their way to move in the matter, but I know there is a strong desire that they should do so. The failure of newly-installed machinery is almost invariably traceable to ignorance, and a competent engineering staff would very soon justify the expenditure, whilst every intelligent worker on the machines would, in course of time, learn how to get the best out of them.

Causes of Industrial Unrest.

Since my previous letter an inquiry has been held here by the Yorkshire and East Midlands Officer—Mr. T. R. Grenside—of the Labour Regulation Department of the Ministry of Munitions, into an allegation of victimisation, the complaint being that six electricians, four of whom were shop stewards, had been dismissed from their employment at Thomas Firth and Sons' works. For the men, Mr. Matthews, secretary of the Electrical Trades Union, appeared, and Mr. Ireson was the firm's representative. The proceedings were lengthy, but in the end Mr. Grenside found that there had been no victimisation whatever. In this connection I may mention that the week-end saw the close of evidence heard by the Commissioners appointed by the Government to inquire into the causes of industrial unrest in Sheffield. The Commission sat at the Town Hall, and during its stay in the district visited a number of the works.

New French Consular Agent.

It may interest firms in the steel trade generally to know that the French Ministry for Foreign Affairs has appointed Mr. C. A. Baglin, of the White Building, Fitzalan-square, Consular Agent for France in Sheffield. Mr. Baglin succeeds Mr A. L. Billot, who for some time now has been serving as interpreter in France.

Round the Works.

Besides the matter of the new laboratories to which I have already referred, there is very much of interest taking place just now. Without, at present, being more definite, I may mention that a more or less veiled reference at a recent university gathering to the future study of refractories has a great deal underlying it, from which developments may be anticipated almost immediately. Then, again, the growing feeling that in the coming fight for new markets there should be a grouping of firms or sections of trades in the common interests of Sheffield's industrial development has given rise to some interesting rumours. One is to the effect that already representative firms have arranged to meet for a general discussion of co-operative effort in the expansion of home and oversea trade, and another is that two well-known steel concerns are negotiating with a view to amalgamation. The latter I know to be without foundation, and the other is, so far as I can see, equally groundless. But such rumours show the trend of thought, and it is certainly in the right direction. Last week I referred to the steel works extensions now proceeding in North Lincolnshire, which somehow or other always seems an outlying portion of the Sheffield district. I mentioned the developments of the Frodingham Iron and Steel Company, and the Redbourn Hill Iron and Coal Company. Now it is learnt that the well-known Bristol firm, John Lysaght, Limited, has allocated £100,000 out of last year's profits for the extension of its steel plant situated in a part of Lincolnshire, in close proximity to the two undertakings mentioned above. These extensions are being made, in agreement with the Ministry of Munitions, on the understanding that the firm shall be allowed, out of excess profits, to provide for a portion of such capital outlay. The Frodingham and Scunthorpe districts of Lincolnshire bid fair soon to become as important to the steel industry as Grantham and Lincoln, and if the three local authorities there were wise they would compose all differences and seek powers to amalgamate the three townships concerned into one borough. In any case, it is a district worth watching. John Brown and Co. have an ironworks there with two or three blast-furnaces. Sheffield has just secured a further interest in that quarter, and the Steel Company of Scotland is half owner of the Appleby Ironworks. The whole district is rich in raw materials. In quite another direction, but in connection with a firm with whose interests Sheffield is much concerned, an interesting enterprise is in hand. The company referred to, which operates iron, steel and coal, has discovered a valuable use for discarded pit props. Instead of scrapping these in the ordinary way, the management is converting them into wood-wool used for packing purposes. It is not an entirely new industry in this part of the country, but hitherto, I believe, it employed largely new wood. Regarding the export business I still hear complaints of its gradual extinction; but a good margin is retained by some means. That more recently booked includes tools for Calcutta, Capetown, Bilbao, and Buenos Aires; files for Gijon and Rosario; saws for Calcutta, Bilbao, and Barcelona; machetes for Accra; electro-plate for Valparaiso and Sierra Leone; hardware for Savanilla, Toronto, Winnipeg, Calcutta, Mombassa, Nairobi, and Buenos Aires; and steel for Melbourne, Bilbao, Guayaquil, Montreal, and Toronto. The Colonies are taking very large quantities of railway, mining, and tool steel. The War-office invites tenders for 2,000,000 small wire nose springs and compression springs for respirators, 1000 mess tin lids, 12,000 6in. blades for metal cutting saws, 6000 chisels, 3000 putty knives, and 2000 gauges. In his review of proceedings before the Munitions Tribunal for June, Sir William Clegg deplores a recrudescence of gambling in the works, but is pleased that in every other way, particularly regarding time-keeping, the record for the month is excellent, there having been only eighty-six cases of time-losing against 111 for the previous month, the hours lost totalling 6717, showing an average of 78.1 hours per case, against May's record of 10,954 hours in 111 cases, with an average of 98.7 per case.

Iron, Steel, and Coal.

There is still little fresh to report regarding iron. It looks as if the number of Derbyshire forge and foundry furnaces changed over to basic iron making may shortly be increased, which, of course, means a certain stringency in the market for the two former makes. The supplies, however, are fairly good, though in common irons Derbyshire furnaces, of which there are just now about thirty in blast—about the same number as the North-West Coast hematite furnaces in blast—are for the time being the chief source of supply here, Lincolnshire being temporarily quite off the market for Sheffield, where basic for the moment is not in much request. Special hematites are coming forward fairly well, but not so freely as users could wish. Deliveries of steel seem to be rather better. The Sheffield production is almost wholly acid, consumers of basic mostly relying upon outside sources of supply. Regarding coal, the Controller's scheme for regulating outputs as from September is, of course, the subject of much discussion. Collieries are not greatly perturbed, because they had a very fair idea of what to expect. Under the scheme no coal will be permitted to be imported into Yorkshire, Derbyshire, and Nottinghamshire, so that contracts between Derbyshire coal owners and Yorkshire works will have to be cancelled, unless the Controller issues a licence authorising supplies of particular fuels for certain special purposes. Apart from anthracite, or smokeless Welsh coal, however, it is generally not a difficult matter to substitute coal in any one area with a similar quality in another. When the scheme comes into operation Yorkshire collieries will be able to supply home needs and to send fuel to Lancashire, the South-Western counties, North Staffordshire, the Birmingham district, Leicestershire, North Hants to Essex and the Eastern counties, and Derbyshire and Nottinghamshire collieries will be permitted to supply coal to Lancashire, North Wales, North Staffordshire, the Birmingham district, the South-Western, South-Eastern, and Eastern counties, and London. The chief trouble is that contracts for house and gas coal and a fair proportion of those for manufacturing fuel run for the twelve months ending June 30th of any year. Where these contracts now have to be cancelled a good deal of bother would have been saved if the Controller's scheme could have been revealed a few days sooner. In the meantime the demand for steam coal for inland consumption keeps on a large scale, and outputs are going out of hand very freely. Exports to neutrals are practically at a standstill, movements being almost wholly to satisfy Government requirements or shipments to Allies. For inland, current values are firmly held per ton at pits as follows :—Best South Yorkshire hards, 17s. 9d. to 18s. 3d.; best Derbyshire, 17s. to 17s. 3d.; seconds and cobbles, 16s. 6d. to 17s.; nuts, 16s. 6d. to 17s. 6d.; small fuels are very active, with little on the open market. Best hard slacks quote 12s. 6d. to 13s.; second quality, 12s. to 12s. 6d.; soft nutty slacks, 12s. to 12s. 3d.; pea slacks, 10s. 6d. to 11s.; and small, 6s. to 7s. House coals are unchanged, though the pressure for delivery to the London district is not quite so severe. Branch quotes, 21s. 6d. to 22s. 6d.; and best Silkstone, 18s. 6d to 19s. 6d. per ton at pit. The coke market is firm at maximum rates.

SAMPLING COAL.

IN Bulletin 116, issued by the United States Bureau of Mines, directions are given for the preparation, in a standard manner, of samples of coal for analysis. In the case of a cargo of coal, weighing, say, 500 tons, it is suggested that a gross sample of 1000 lb. should be collected as the coal is being loaded or unloaded. This gross sample is to be gathered by accumulating equal increments at regular intervals, the first and last increments tallying respectively with the beginning and ending of the loading operations. The size of the increments may be from five to ten pounds in the case of slack or small sizes of anthracite, but for run-of-mine or lump coal they should be at least from 10 lb. to 30 lb. each.

The gross sample of 1000 lb. weight thus accumulated has to be reduced to two 5 lb. samples, one for the laboratory and one for reserve. A method of effecting this reduction in a proper manner is described. The implements required are simple, and consist of a shovel, tamper, broom and rake. A blanket, measuring some 6ft. by 8ft., is also required. The division of the gross sample should be conducted on a hard, clean floor, free from cracks and protected from rain, snow, wind, and strong sun. The sample during the division should, of course, be protected from any loss or gain in moisture.

The gross sample is first crushed with the tamper until no piece in it measures more than 1in., as judged by the eye. After crushing, the sample is raked into the form of a cone. To mix it properly it is then formed by separate shovelfuls into a long pile. This pile is next divided into two portions with the shovel. In doing so the sampler starts with his shovel at one end of one long side of the pile, passes round the other end, and then goes down the other long side. The odd shovelfuls taken from the pile are placed in one heap, and the even shovelfuls in another. One of these 500 lb. heaps is rejected. The other is crushed with the tamper until no piece in it appears larger than $\frac{3}{4}$in. The heap is then raked into a cone, formed into a long pile with the shovel, and halved as before. One of the 250 lb. heaps is rejected. The other is divided in two.

This third division of the gross sample is commenced by crushing the heap to a $\frac{1}{4}$in. size, as judged by the eye. The heap is then raked into a cone and is mixed, not by forming a long pile, but by shovelling it into the shape of a similar cone. This cone is flattened into a circle which is quartered by scraping it into four quadrants with the shovel. Two opposite quadrants are rejected; the remaining two are retained. The sample has now been reduced to about 125 lb. in weight. This is crushed with the tamper to a $\frac{3}{8}$in. size, the crushing this time taking place, not on the bare floor, but on the blanket. The sample is then mixed by rolling it on the blanket, and by suitable manipulation of the blanket ends is formed into a cone-shaped mound. This mound is flattened and quartered as before with the shovel. Two opposite quadrants are swept off the blanket with the broom and rejected. The remaining 60 lb. or so are crushed on the blanket to $\frac{1}{4}$in. size, and are mixed, coned, and quartered as before. Finally, the 30 lb. sample is crushed to $\frac{3}{16}$in. size, and treated similarly. From the 15 lb. remaining after it is quartered two 5 lb. sample containers are filled.

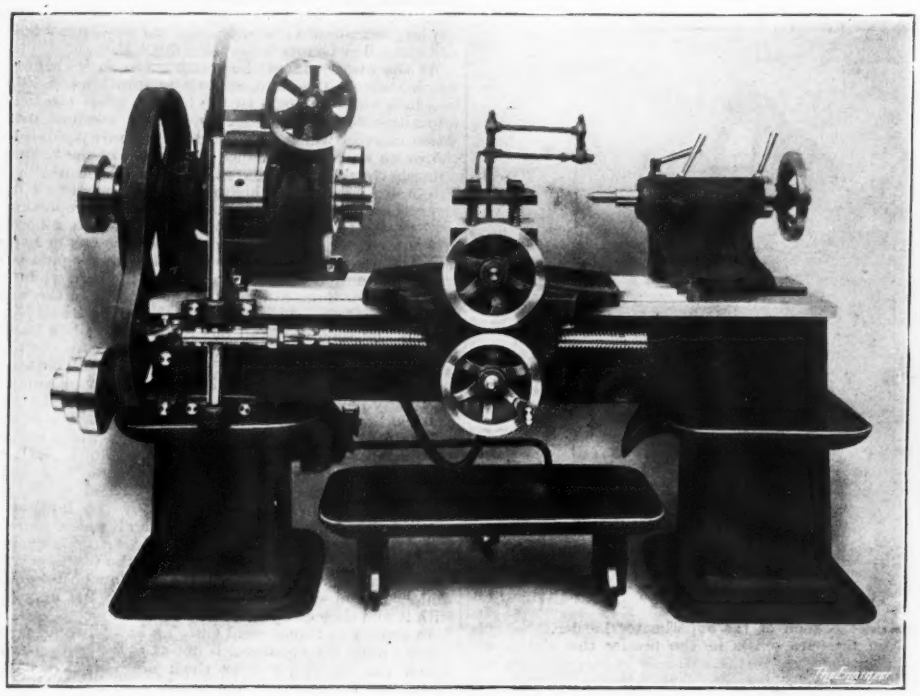
THE master mechanic of the Lorain division of the Baltimore and Ohio Railway has announced that he will employ women in any capacity which they can fill. It is proposed to employ them as car repairers, switch women, crossing guards, signal women, and in clerical positions. It is stated that the women will draw the same wages as men occupying similar positions.

THE dining car superintendent of the Northern Pacific Railway has, it would appear, made a speciality of the size of the baked potatoes supplied to his patrons. It has recently been announced that "The Northern Pacific has deemed it wise to discontinue the serving of the Great Big Baked Potato in its dining cars during the term of the war, so that there shall be no waste through a passenger being served with more than he can eat of a single item."

THE board of six presidents which form the Railway Executive Committee of the United States is said to have agreed that there are too many duplicated passenger trains between given points, and that freight traffic could be expedited and considerable economy effected if some of these passenger trains were cut off for the period of the war. It is the theory of the Committee that curtailment to this extent will be a matter of inconvenience rather than actual injury, and that it will be accepted cheerfully as one of the conditions of war.

NINE-INCH TAPER-TURNING SLIDING LATHE

HARRY F. ATKINS, OLD FLETTON, PETERBOROUGH, ENGINEER



9-INCH TAPER-TURNING SLIDING LATHE.

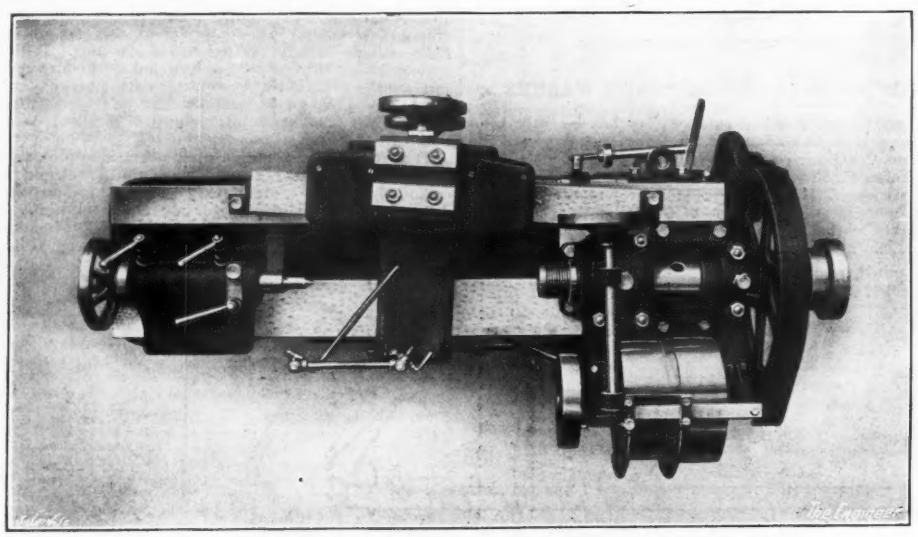
A 9IN. taper-turning lathe which has been specially designed for turning aeroplane engine cylinders, but which has also a field of usefulness wherever tapers have to be turned or tapers formed in conjunction with parallel cylindrical surfaces, has recently been introduced by Mr. Harry F. Atkins, of Old Fletton, Peterborough.

The special feature of novelty in this tool, which is illustrated in the accompanying engravings, is the method of obtaining the tapers, which is effected without the inherent weaknesses which are present in so many forms of tapering attachments as usually fixed. In the tool under consideration, the front shear by which the movement of the saddle is guided is virtually swivelled. The swivelling shear is pivoted on a central clamp pin and is also clamped firmly at each end, so that it is held down solidly to the front shear at three places.

The plan view illustrates the principle very clearly, and the maker draws attention to the following points as being greatly in its favour :—(1) The rigidity is as great as that of an ordinary parallel turning lathe of similarly massive proportions ; (2) the front swivelling shear forms a long narrow guide for the saddle ; and (3) this guide is directly above the screw from which the traverse is obtained, this obviating the twisting moment on the saddle common to all taper-turning attachments.

The lathe itself is strongly built and has a specially designed bed 16in. wide. The headstock is driven by a 4in. belt on a pair of 12in. fast and loose pulleys geared down six to one to the spindle. The front bearing of the spindle is 5in. diameter by 7in. long, and runs in white metal bearings furnished with wick lubrication. The thrust is taken by a ball-bearing washer. Provision is made for clamping the spindle during the removal of the jig or chuck from the spindle. The belt is shipped by means of a hand wheel at the front, so as to be readily accessible to the operator, and provided with a locking device both ways.

The loose headstock is clamped to one edge of the back shear by means of two bolts actuated by handles situated at the front of the lathe. The advantages claimed for placing the loose headstock on the back shear are :—(1) That a long guide can be obtained for the saddle without necessitating an objectionable length of overhang of the headstock barrel ; and (2) that it brings the thrust of the cut directly between the ways of the lathe bed, thus producing rigidity. This method of fixing the poppit to the back shear of course introduces entirely new stresses on the bed itself, but the design is specially adapted to meet them. The feed is obtained by a screw with three speeds ; and an automatic knock-off is provided. In order to accommodate the movement of the saddle across the bed when taper turning, a feed screw is provided with a universal joint at one end and the nut in the apron is capable of swivelling. A hand traverse is obtained by a hand wheel at the front of the apron geared on to the screw itself. Pump piping, tray and tank are incorporated in the design.



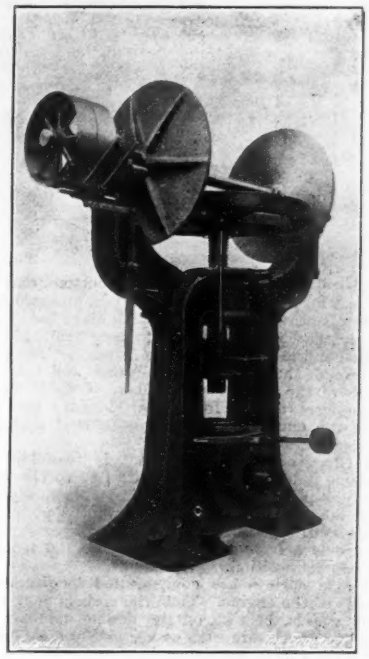
PLAN VIEW OF NINE-INCH TAPER-TURNING LATHE

250-TON FRICTION SCREW PRESS.

THE illustration represents the latest design of friction screw press made by Joseph Rhodes and Sons, Limited, Wakefield. This class of press is being largely used for forging, embossing, and forming metals, and the makers claim that the action of the ram is more uniform than that of the drop hammer, and that being under the direct control of the operator the blows can be varied at will. The press illustrated is designed to give a blow of 250 tons. As will be seen, it is belt driven. In action the balanced lever at the front is depressed, and when this occurs one of the vertical discs comes into frictional contact with the fly-wheel, which is faced with Ferodo. The friction set up between these faces rotates the screw. The screws are made of nickel steel, so that they may stand up well to the heavy stresses imposed on them. The lower extremity of the screw enters the ram and bears on a steel plate, which is hardened and ground to resist wear and ensure the minimum of friction. The discs are of cast iron, and are adjustable on their shaft by means of fine threaded nuts, to compensate for wear of the driving band, the movement of the starting lever being thereby kept within reasonable limits. The driving shaft is of large diameter to ensure stiffness, but as an additional safety device swivel bearings are fitted, which have a length of bore equivalent to four diameters of the shaft.

The body casting is in one piece and made of heavy design, so as to absorb any effort which the fly-wheel is capable of giving out. There is on the head a phosphor bronze nut of special shape cast from a particular mixture, and the threads of both screw and nut are cut in the lathe so as to ensure accuracy. The screw on the press illustrated has five leads, and the angle of thread is designed to prevent locking when subjected to pressure. Two adjustable stops are fitted as shown. One of these regulates the height to which the ram can rise, thereby controlling the force of the blow, and the other comes into use when performing blanking and punching work.

To operate the press, the starting lever is depressed and pressure is maintained on it until the ram has descended and performed its function, when the lever is released. The balance weight acting through the levers immediately brings the other disc in contact with the driving band, which turns the screw in the opposite direction. The ram ascends until a projection engages the top adjustable stop, when the driving disc is brought into contact with the driving band and absorbs the kinetic energy in the fly-wheel and brings it to rest. The ram is thereby certain to be arrested at the top of its stroke, as any tendency to move downwards causes the "lifting" disc to engage the driving band on the fly-wheel, through the medium of the balance weight.



RHODES' 250-TON FRICTION SCREW PRESS

The leading dimensions of the press are as follows :—Diameter and width of pulleys, 20in. by 4¾in.; maximum stroke of ram, 14in.; maximum distance ram to bed, 20in.; width between sides, 23in.; width between slides, 18in.; width of bed back to front, 22in.; hole in the bed, 6in. diameter ; hole in ram, 2¾in. diameter by 4¾in. deep. The overall diamensions are :—Back to front, 5ft.; left to right, 9ft. 8in.; height, 11ft. 5in. ; and the weight, 7½ tons. The proper speed for the pulleys is 180 revolutions per minute, and the horse-power required is, with group drive ten, and with separate drive fifteen.

These presses are made in many different sizes to give pressures varying from 30 to 1000 tons.

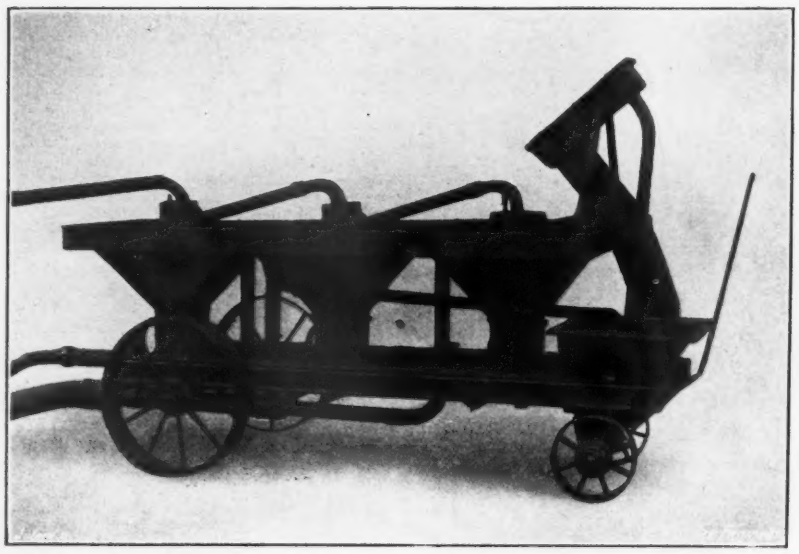
BRITISH-BUILT TANK LOCOMOTIVES FOR THE PARIS-ORLEANS RAILWAY.

IN our issue of March 9th we illustrated and briefly described one of a set of "Mikado" type tank engines, built by the North British Locomotive Company, Limited, of Glasgow, for the Paris-Orleans Railway, to the designs of Monsieur E. Solacroup, Ingénieur-en-Chief du Matériel et de la Traction.

The engines, as was shown in the views given in that issue, have a 2–8–2 wheel arrangement, with eight of the wheels coupled. One of the drawings reproduced in the Supplement indicates the design of the rear two-wheeled truck or bogie. The truck frame is a casting, A-shaped in plan. At the apex there is fixed a ball-headed pin, which engages within a spherical bearing provided at the centre of a frame stretcher-like casting situated beside the rear coupled axle. The casting referred to is in the nature of a box enclosing the axle. Its ends slide within horn-blocks, and are formed with internal seatings for the axle journals. The casting may alternatively be described as a pair of axle-boxes united by two channel-sectional webs. To the base end of the A-frame a somewhat similar box casting is bolted for the reception of the truck axle. Near its middle the frame is formed with two cross-bars. Within the rectangular space here left a species of universal bearing is provided for a pin, the head of which is splayed out like a flange, and bolted to a plate-and-angle stretcher fixed between the main frames of the engine. The universal bearing consists of three members, namely,

PORTABLE FILTER BED SAND WASHER

HUNTER AND ENGLISH, LIMITED, BOW, ENGINEERS



a cylindrical piece, flattened top and bottom, and pierced at the centre, to fit on to the fixed pin, and two external members, concave on the inside, to fit on to the cylindrical piece, and flat on the outside, to bear against the faces machined on the cross bars of the A-frame. Two plungers pass through the sides of the A-frame, and bear against the ends of the cylindrical member. Outside the frame these plungers take the form of buckles for a pair of plate springs, the ends of which are connected crosswise by two rods adjustable in length.

The effect of this arrangement is twofold. In the first place, it leaves the truck axle free to rise and fall. Secondly, it permits the axle to swing horizontally through a small arc round the ball-headed pin as pivot. When this occurs the plate springs, reacting against the fixed pin, provide a force tending to restore the truck frame to the central position.

The axle springs are compensated longitudinally on each side of the engine. Thus the springs of the trailing coupled wheels, bearing on the double axle-box casting referred to above, are each connected by a compensating lever to the spring, on the same side, for the truck axle. The buckles of the truck springs are provided with round-headed studs on the undersides. These studs bear within the concave heads of vertical plungers, which can slide within bushed bearings formed in brackets fixed to the inner surfaces of the main frames. The ends of the plungers rest on blocks, which can slide on surfaces prepared on top of the truck axle-box casting. The sliding blocks lie within box-like portions of the casting, on top of which there rest plates which close the opening and keep grit and dirt away from the sliding surfaces.

The second engraving in the Supplement shows the smoke-box arrangement. The engine is fitted with a Schmidt superheater and with a variable blast-pipe. In connection with the superheater it may be remarked that no dampers are provided, such as at one time were thought necessary to avoid burning the superheater elements when steam was shut off. It will be noticed, however, that the natural draught up the chimney can be interrupted at will—as, for instance, during a long period of standing—by means of a rotatable damper, which closes over the chimney top.

The same engraving illustrates the provision made for automatically closing and opening the by-pass valves on the cylinders when steam is turned on and shut off respectively. A small single-acting steam cylinder is fixed to the left-hand outside of the smoke-box. A pipe connects the forward end of this cylinder with the main saturated steam inlet branch of the superheater header. So long as steam pressure exists in the header the piston will remain pushed over to the left, and in this position will maintain raised the weighted lever attached to the shaft which operates the by-pass valves. When steam is shut off the weighted lever falls and opens the by-pass valves, so putting the two ends of each cylinder into communication. Provision is made for automatically draining the small operating cylinder of any steam which may condense in it while it is in action.

The third drawing in the Supplement represents the cylinder and valve-motion arrangement. The valve gear is of the Walschaerts type, the steam distribution being effected by means of piston valves arranged for inside admission. A relief valve is provided at the mid-point of each valve chest, to prevent the establishment of a vacuum in the steam pipes during periods of running with steam shut off. As in the case of the engines for the French State Railways, built by the same firm, and described in our issues of August 4th and September 29th, a counter-pressure brake system is provided. Some indication of the manner in which this arrangement works is given in the second of the issues named.

PORTABLE FILTER BED SAND WASHER.

A PORTABLE filter bed sand washer has recently been designed and put to work at the Roughrigg Works of the Airdrie, Coatbridge and District Water Trust, by Mr. John Chisholm, M. Inst. C.E., who is engineer and manager to the Trust. The washer, which is illustrated in the accompanying engravings, is of the Polglase type, but is portable, so that, if required, it can be used actually in the filter, the sand of which is being washed. As will be observed, the apparatus consists of four hoppers carried on two longitudinal joists mounted on four wheels having ball bearings, the front pair of which can swivel.

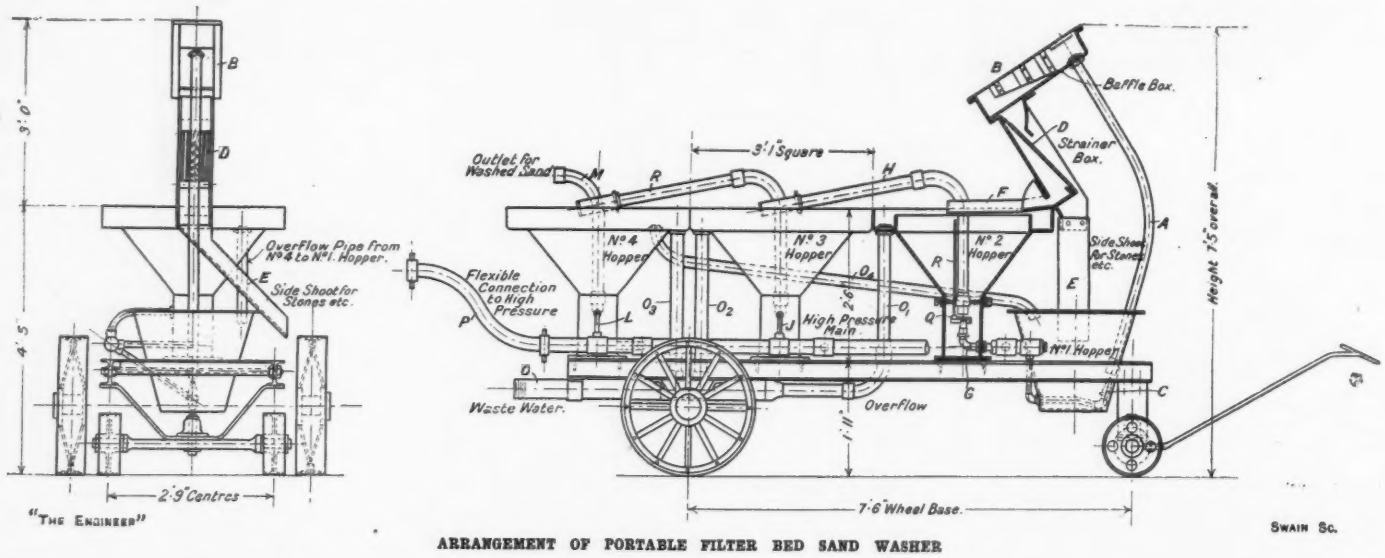
It will not be necessary to discuss the principle on which the washer works, since the Polglase washer was described in considerable detail in our issue of Feb. 16th, 1912, but we may say that the sand to be washed is shovelled into No. 1 hopper, which is arranged at a convenient height for the purpose, and is kept full of water. Dipping down rather more than half-way into the hopper is a pipe A, which leads up to and delivers into an inclined baffle box B arranged well above the rest of the apparatus. A stream of high-pressure water and air is directed through a nozzle C placed in the hopper immediately below the lower orifice of the pipe A, and this stream or jet entrains the sand and takes it, with a certain amount of water, up the pipe and into the baffle box. As the mixture of sand and water flows down this box, it is thrown from side to side and a good deal of cleansing takes place. The delivery from the baffle box is into the strainer box D, in which any large particles of stone, &c., and any weeds are arrested, and can fall or be raked down the shoot E.

At the lower end of the strainer box is a channel F which delivers the sand and water into hopper No. 2, in which the sand falls to the bottom, while the lighter impurities float to the top, where they overflow into a waste channel which is drained by a down pipe O_1 into the waste water pipe O. At the bottom of the hopper is a nozzle G, which is similar to the nozzle C, and which, like it, obtains its supply of high-pressure water and air from the pipe P. The partly washed sand with a proportion of water is forced up through the pipe H into No. 3 hopper, where the same cycle of events takes place as in hopper No. 2, the sand and water being forced up the pipe K by the jet J and delivered into No. 4 hopper, while the surplus water flows away down the pipe O_2 to the waste pipe. Hopper No. 4 is similar to hoppers No. 2 and No. 3, and by the time the sand has reached it, it has become sufficiently washed. It is therefore ejected by the high-pressure jet flowing through the pipe L, and passes up through the pipe M, from which a connecting pipe may be led to any point to which it is desired to deliver the sand. The last hopper, in addition to having an overflow pipe O_3 is furnished with another pipe O_4 through which some of the surplus water flows back into hopper No. 1.

It should be explained that in hoppers 2, 3 and 4 the volume of water and sand introduced at the top, plus the air and water introduced by the injector, is greater than the volume of sand and water removed from these hoppers by their injectors. Consequently, a proportion of the water must rise to the top in order to escape, and as it does so, it meets the flow of descending sand. The upward stream carries away the impurities with it and they escape with the waste water.

In order to prevent sand entering and blocking up the nozzles when the apparatus is not at work, cover plates Q which can be swung over them are provided. These plates are thrown over the nozzle or away from it by means of a vertical rod R, which is manipulated from above the top of the hopper. As will be observed, the pipes leading to the various nozzles each have their own regulating valve.

The washer was made by Hunter and English, Limited, of Bow.



ARRANGEMENT OF PORTABLE FILTER BED SAND WASHER

CAUSTIC SODA CONCENTRATION PLANT.

A LARGE quadruple effect caustic soda concentrating apparatus of the latest design, which is intended for an output of 200 tons per week, has been shipped abroad from Glasgow. Other concentrators of a different size have also been sent to France from Scottish engineering workshops; and these classes of apparatus embody the newest ideas for effective results. The quadruple effect concentrator is equipped with multiple heaters for heating up the cold lye to boiling point before entering the evaporating tubes. The capacity of this apparatus is 2000 gallons hourly, raised from 20 deg. T.W. to 60 deg. T.W. It is entirely of iron and steel construction, and is of the well-known type of which a number of sextuple effects are giving great satisfaction on the Continent, supplied by the same makers, the Mirrlees, Watson Company, Limited, Glasgow.

The efficiency of the quadruple effect is approximately 3 to 1; and the guaranteed efficiency of a sextuple plant on soda lye is 4 to 1, viz., for each 1 lb. of primary steam 4 lb. of water are evaporated out of the solution. This ratio is lower than that of similar sextuple effects employed in distilling from sea water, where the guaranteed efficiency is 4½ to 1, in addition to utilising the condensed steam in the first effect for boiler feeding or other purposes.

In the quadruple plant, which is of very large size, the vapour from the separator attached to the fourth or lowest effect passes through a horizontal saveall into a surface condenser containing sufficient cooling surface, not only for the quadruple plant, but also for a double effect evaporator of the vertical type, which treats the 60 deg. T.W. lye, raising it to 100 deg. T.W.

The vessels of the double effect are respectively 6ft. and 7ft. diameter, having tubes of special material expanded into cast iron tube plates 2½in. thick. The upper tube

plates also form part of the belts or bodies of the vessels, the juncture being above the working level of the lye when boiling. The bottom tube plate of each vessel is cast in one with the steeply sloped bottom, the weights of these calandrias or heating portions of the vessels alone being 14 and 15½ tons respectively. Isolating valves are provided, enabling both plates to be jointly or independently worked.

The pumping plant comprises an air pumping engine of the horizontal wet type with steam cylinder 20in. diameter, pump 26in. diameter, both being 24in. stroke; also vertical duplex circulating pump for the surface condenser, and pumps of similar type for feeding, discharging, and draining the quadruple apparatus, along with similar feeding and discharging pumps for the double effect plant, the draining of the distilled water from the latter being direct into the surface condenser.

THE HEATING SURFACE OF BOILERS FOR LOCOMOTIVES.

THERE has been from time to time some slight difference in the method of calculating the heating surface of locomotive boilers. A little time ago the Association of Railway Locomotive Engineers appointed a committee to regularise the mensuration of the heating surface of locomotive boilers, and decided that the method to be employed by the members—to be known as the "Association of Railway Locomotive Engineers' method of calculating the heating surfaces of locomotives"—should be as follows:—

Fire-box.—The outside (wetted surface) of inner fire-box plates to be taken to top of foundation ring. Areas of tube-holes and sectional area to wetted side of fire-hole ring, or flanged plate, as the case may be, to be deducted; section of fire-hole being taken close up to the inner fire-box plate.

No deductions to be made for copper stays or roof stays. If the boiler has fire-box water tubes the surface to be taken on the inside (wet side) of tube.

Tubes.—The outside surface of tubes (wet side) to be taken, calculated on uniform diameters for both ordinary and superheater tubes; the length of tube being taken between tube-plates.

Elements.—The inside surface (steam side) of elements to be taken, the effective length of tube being from and to smoke box end of large flue tube.

Smoke box tube-plate.—No allowance to be made.

We are sorry to observe that the Association expresses no opinion as to whether superheater surface should be included in heating surface or not. Our own view is that it should not be, and that heating surface means evaporting surface.

AGRICULTURAL MACHINERY.

THE Agricultural Machinery Department of the Ministry of Munitions will, it is officially announced, require during the next twelve months a minimum of agricultural implements as follows:—8000 Horse-drawn ploughs; 2000 cultivators; 2000 seed drills; 2750 rollers; 5500 harrows of ridged and jointed type; 400 land presses; 7000 self-binders; 1400 disc harrows, both tractor and horse drawn; 400 horse-drawn farm tip carts; 100 horse-drawn flat top lorries; thrashing machines, 3ft. 6in. and 4ft. 6in.; cultivators for tractors; some thousands of two-furrow ploughs for tractors of a special design.

Any firms who, in addition to their normal output could undertake the whole or part of this work, are asked to communicate with The Controller, Agricultural Machinery Department, Ministry of Munitions of War, 8, Northumberland-avenue, W.C. 2, stating total output, date delivery could commence, and rate per week.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W.

ORDERS.

For the week by Lieut.-Col. C. D. Clay, V.D., Commanding.

Officer for the Week.—Platoon Commander A. Gerard.
Next for Duty.—No. 3 Company.
Appointment.—Dr. Hugh Gibbon to be Medical Officer.
Promotions.—Acting Corporals Gillespy and Salisbury to be Corporals.
Monday, July 16th.—Technical Instruction for No. 3 Company, Right Half Company, Regency-street. Drill No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill 6.30.
Tuesday, July 17th.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.
Wednesday, July 18th.—Drill No. 1 Company, Left Half Company.
Thursday, July 19th.—Drill No. 2 Company, Left Half Company. Ambulance Class, 6.30. Signalling Class.
Friday, July 20th.—Technical Instruction for No. 3 Company, Left Half Company, at Regency-street. Drill for No. 3 Company, Right Half Company. Recruits' Drill, 6.30.
Saturday, July 21st.—N.C.O.'s Parade, 2. Map reading.
Sunday, July 22nd.—Parade will be at Esher for Engineering Instruction.
Armlets.—Members are warned that armlets must be worn at all plain clothes parades.
Musketry.—For all companies see notice at headquarters.
Note.—Unless otherwise indicated all drills will take place at headquarters.

MACLEOD YEARSLEY,
Company Commander and Adjutant.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

RUSTON, PROCTOR AND CO., Limited, of Lincoln, have moved their London office from 46, Queen Victoria-street, E.C., to West Africa House, Kingsway, W.C. 2.

WE are informed that Mr. James A. Goodwyn, Mr. John H. W. Pawlyn, and Mr. Victor W. Bone have joined the Board of Ransomes, Sims and Jefferies, Limited, of Ipswich, as managing directors.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

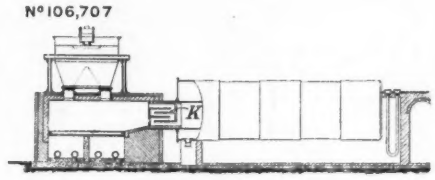
The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

106,707 (9765 of 1916). July 11th, 1916.—STEAM BOILER FURNACES, George Edward Heyl, King's House, Kingsway, London, W.C.

In order to eliminate the noxious constituents of the products of combustion of sulphur-containing fuels, this invention provides, between the furnace and the flues of the generator, an arrangement consisting of a series of superposed shelves and passages leading downwards to direct the products of combustion

N° 106,707



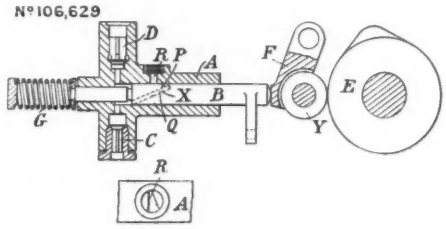
to impinge on sulphur absorbing reagents placed on the shelves, and sweep successively over the contents of the several shelves. The arrangement is clearly shown in the illustration, K being the shelves on which iron scrap, or a mixture of this with ferric oxide, is disposed to absorb any sulphuretted hydrogen which may not have been consumed in the furnace.—*June 7th*, 1917.

INTERNAL COMBUSTION ENGINES.

106,629 (4381 of 1916). March 24th, 1916.—FUEL PUMP FOR DIESEL ENGINES, Hugh Emile Fenchellè, Viâ XX. Settembre 34/4, Genoa, Italy, and 9, Cloak-lane, London, E.C.

A is the pump casing, within which works the plunger B provided with a relief passage. C is the suction valve and D the delivery valve of the pump. E is a cam operating the pump through the intermediate member F having the cam roller Y. The suction stroke of the plunger is effected by means of the spring G mounted on the end of the plunger extension. The spring keeps the opposite end of the plunger up against F, maintaining the cam roller Y against the cam E. Assuming the pump chamber to be filled with fuel at the end of the suction stroke of

N° 106,629



the pump, the cam E as it turns to meet the roller Y drives in the plunger B against the pressure of the spring G, causing the annular shoulder of the pump plunger to compress the fuel in the pump chamber, and to force it at high pressure through the delivery valve D, from which it passes to a suitable spraying nozzle or atomiser in the engine cylinder. The delivery of the fuel continues until the outer end P of the relief passage Q reaches the relief outlet R in the casing A, when the pressure on the fuel is instantly relieved, permitting the delivery valve D to close, while the fuel during the remainder of the compression stroke escapes through the outlet port R, whence it may pass to the suction side of the pump.—*May 24th*, 1917.

106,635 (5059 of 1916). April 6th, 1916.—INTERNAL COMBUSTION ENGINES FOR HIGH ALTITUDES, Henry Watson, 38, Marlborough-road, Wimbledon Park, London, S.W., and others.

This invention is for an apparatus for supplying air for the explosive mixture to an internal combustion engine at constant pressure equal to atmospheric pressure at sea level, irrespective

N° 106,635.

Fig. 1.

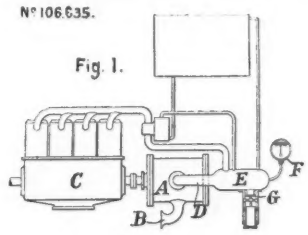
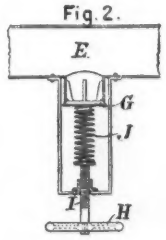


Fig. 2.



of altitude or atmospheric pressure variations. The apparatus comprises an air compressor, a container supplied with air by the compressor, and connected with the carburetter, and means for maintaining the air in the container at a constant pressure. As shown, an air compressor A, Fig. 1, having a bell-mouthed air inlet B, facing the direction of travel, is driven by the engine C, either direct as illustrated, or through gearing, the capacity of the compressor being such that it is capable of supplying the full volumetric air requirements of the engine, and maintaining the supply at the normal atmospheric pressure of about 14.75 lb. per square inch at whatever altitude the engine may be working. The delivery or outlet D of the compressor A communicates with a container E provided with a pressure gauge F and relief or escape valve G adjustable by hand or automatically, according to altitude. Fig. 2 illustrates a hand control arrangement consisting of a hand wheel H and screw spindle I, by means of which the pressure of a spring J acting on the valve may be increased or decreased as desired. Automatic control arrangements are also described which ensure the opening of the valve when the pressure in the container E exceeds 14.75 lb. per square inch.—*June 7th*, 1917.

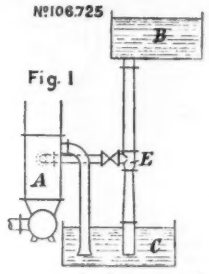
CONDENSERS AND FEED-WATER HEATERS.

106,725 (11,210 of 1916). February 9th, 1917.—JET CONDENSERS, Willans and Robinson, Limited, Rugby, and another.

This invention is for a combination of a jet condenser A with a suction tank or well C situated considerably below the level of the source of supply B of condensing water, and with a water jet air ejector E. The whole is so disposed relatively, and so connected up, that the actuating water of the air ejector is obtained from the source of supply B and discharged into the suction tank C, to be afterwards drawn into the condenser to be used as condensing water, the air ejector withdrawing the air from the condenser, and the difference in level between the source of supply

N°106,725

Fig. 1



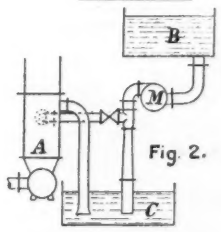


Fig. 2.

and the suction tank being utilised to provide the whole or part of the head of water required by the ejector. Fig. 1 shows an arrangement in which the difference in level between the source of supply B and the suction tank C is sufficient to provide the head required by the air ejector. For this purpose it is desirable to have a difference in level between B and C of about 16ft. or 20ft. When the difference in level between the source of supply and the suction tank is insufficient for working the ejector and maintenance of the required vacuum, the static head, due to the difference in level between B and C, may be supplemented by the head produced by a pump M.—*June 7th*, 1917.

LOCOMOTIVES.

106,793 (30 of 1917). January 2nd, 1917.—COALING MECHANISM FOR LOCOMOTIVES IN MOTION, John Mickeal Briggs, 1239, Terrace-street, Martins Ferry, County of Belmont, Ohio, U.S.A.

Figure 1 is a plan view of a device constructed in accordance with the invention. Fig. 2 is a sectional view taken on the line 2—2 in Fig. 1. A designates a trestle structure having rails B on which the crane C moves, the crane being equipped with wheels D. The crane supports a motor E which drives a feed screw F operating in a tubular casing G, communicating at one end with a source of supply, such as a hopper H. The tubular casing G

N° 106,793

Fig. 1.

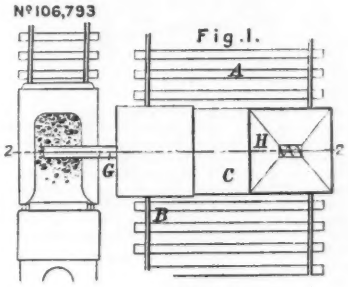
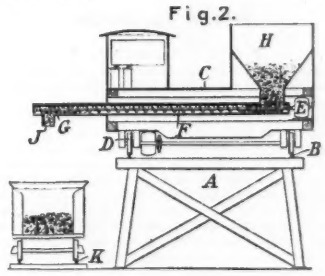


Fig. 2.



extends at one end beyond the crane, the extended end having a discharge spout J, which is so positioned as to be directly above a railway track K, alongside and parallel with which the trestle A is erected. In the operation of this device the crane C is moved at a speed commensurate with that of the train which is to be

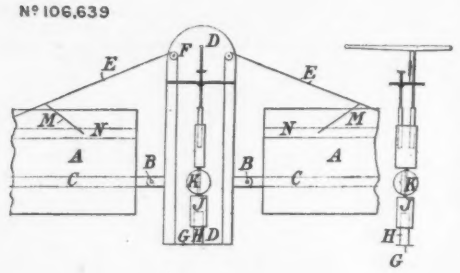
coaled, the discharge spout J having first been brought to a position directly above the tender of the locomotive. The feed screw F is then rotated, thereby supplying coal from the hopper H to the tender.—*June 7th*, 1917.

AERONAUTICS.

106,639 (6341 of 1916). October 21st, 1916.—VERTICAL STEERING OF AEROPLANES, Gerard Stuart McGregor, formerly of 30, Princes-square, Bayswater, London, W. (now of Fort Grange, Gosport).

This invention provides elastic pressure means for steering an aeroplane in a vertical direction by a pneumatically cushioned piston or pistons connected with the wings. The wings A are pivoted at B at the inner ends of their rear main spars C to the fuselage D of the aeroplane, and are connected by cables E passing around guide pulleys F on the fuselage D with a cross piece G carried by a piston H which extends lengthwise of the fuselage in a cylinder J charged with glycerine or other liquid and provided with an air compression chamber K, the liquid serving to seal the sliding joint. The piston is thus connected by the cables E with the leading edges of the wings A in such manner that when the wings are forced rearwardly the air in the compression chamber K is compressed until its pressure balances the pressure acting against the wings. The pull of each cable E is preferably distributed along the leading edge of its wing by a

Nº 106,639

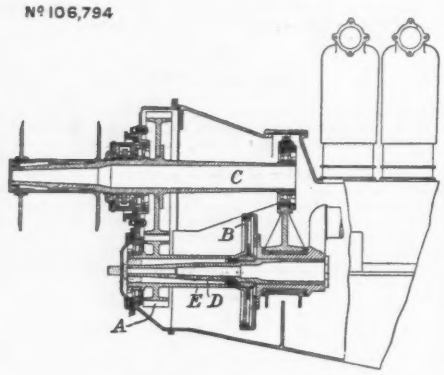


sliding connection between the end of the cable E and auxiliary cables M attached to the spars N of the wings. According to a modification of this arrangement, each wing A is pivoted at the end of its front main spar N and is connected by a link which is attached to the end of its rear main spar C with a separate piston, the respective pistons being fitted to work in opposite directions transversely of the fuselage in a single cylinder. In both forms a plunger may be adapted to be forced into the cylinder by the pilot and locked in position in order, by varying the effective capacity of the cylinder, to determine the position which the piston or pistons will occupy and consequently the angular position of the wings relatively to the longitudinal axis of the machine when the balance of pressures is attained.—*June 7th*, 1917.

106,794 (60 of 1917). January 2nd, 1917.—REDUCTION GEAR FOR AERO-ENGINES, Frederick Henry Royce, Nightingale-road, Derby, and others.

The objects of the invention are:—First, to provide flexible driving means between the crank shaft and the gearing, and convenient means for aligning the driving means. Secondly, to reduce the load thrown on the end bearing of the power shaft, and also the bending stresses on the power shaft due to the torque reaction of the gearing. The objects are attained by driving the gear pinion A of the crank shaft through a flexible coupling B, by mounting the gear in such a position that a

Nº 106,794



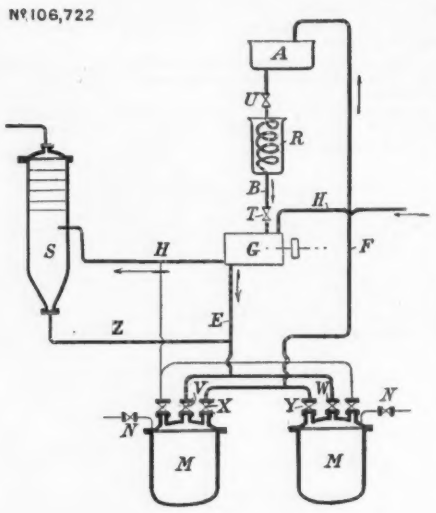
bearing on the outside takes the larger portion of the load due to the torque reaction of the gear, and by providing a radial adjustment for the outer bearing as well as a radial adjustment for the bearings of the secondary or propeller shaft C. In order to facilitate the alignment of the crank shaft gear pinion, the inventors arrange an extension piece D on the crank shaft which passes through the hollow pinion shaft E in such a manner that an annular space is left between the extension piece and the hollow shaft into which a gauge or test piece may be inserted.—*June 7th*, 1917.

MISCELLANEOUS.

106,722 (11,122 of 1916). August 7th, 1916.—PROCESS FOR COMPRESSING CHLORINE, Societa Italiana di Elettrochimica, and another, 66, Via Due Macelli, Rome, Italy.

This invention relates to the compression of chlorine and other gases. The object is to provide an improved system wherein the sulphuric acid used in the compressor is cooled before use and is subsequently collected for use again, and any of the acid carried forward with the chlorine is separated and returned to the system. An elevated feed tank A, containing sulphuric acid maintained at 94–96 per cent. H_2SO_4 communicates with a rotary compressor G by means of a pipe B the flow through which is controlled by cocks T and U, while a serpentine cooler R is arranged between the cocks for ensuring the cooling of the sulphuric acid before it enters the compressor. The chlorine is supplied to the suction end of the compressor G by a pipe H. A pipe E having two branches controlled respectively by cocks V and W conducts the sulphuric acid discharged from the compressor into one or the other of two vessels M. The cocks X and Y on these vessels connect either of them when its cock is opened to a pipe F which leads back to the feed tank A. On the vessels M are also provided cocks N for controlling the supply of compressed air to the vessels for the purpose of forcing out the sulphuric acid through pipe F to the feed tank A. The compressed chlorine discharged from the compressor G passes through a pipe H to a centrifugal diaphragm separator S, from

Nº 106,722

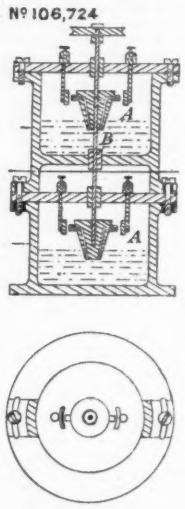


which latter it passes out through a delivery pipe. Any sulphuric acid carried forward with the chlorine and removed in the separator S is conducted by a pipe Z to the pipe E which leads to the vessels M.—*June 7th*, 1917.

106,724 (11,175 of 1916). August 8th, 1916.—MERCURY INTERRUPTER AND INDUCTION COIL, Leslie Bradley Miller, 68, Hatton-garden, London, E.C.

The object of this invention is to provide a mercury interrupter and an induction coil suitable for the heaviest discharges. A double interrupter is provided, and the primary of the induction coil is preferably wound with two circuits having the same impedance, and the break adjusted to synchronism. The interrupter consists of two vessels A, A for the mercury, one

Nº 106,724



mounted over the other, but capable of adjustment in a circular direction. The vertical spindle B is common to both, and passes through a mercury-tight bushed hole in the bottom of the upper pot. Or the spindles may be geared together. Each of the two windings on the coil is fed by one of the two interrupters, and the actual instant of make or break of the current can be adjusted to coincide, or to differ by a definite period of time, at will. By this means double as much current can be broken in the combination of the two vessels as in one alone.—*June 7th*, 1917.

MINES AND METALS.

106,626 (3067 of 1916). March 1st, 1916.—ELECTRIC ARC FURNACES, T. H. Watson and Co. (of Sheffield), Limited, Lancaster-street, Neepsend, and others.

This invention relates to a method of distributing two-phase and three-phase currents to electric arc furnaces or resistance

Nº 106,626

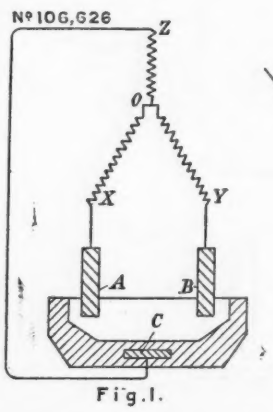


Fig. 1.

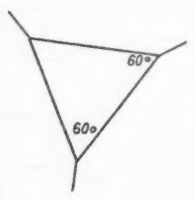


Fig. 2.

furnaces, and consists in an improved arrangement and grouping of the secondary windings of transformers on two-phase or three-phase primary supply systems, in such a manner that two equal resistances and one unequal and lesser resistance may be connected across the secondary terminals of the said transformers and a balance maintained in the load on the supply phases both in power and power factor. Fig. 1 shows the invention as applied to a three-phase supply system, and Fig. 2 is a diagrammatic sketch of the arrangement of primary windings. A furnace, as shown in Fig. 1, having two top electrodes or groups of electrodes A, B, and a conducting hearth or bottom electrode C, is connected with the terminals of the secondary windings of three single-phase transformers OX, OY, OZ, which are grouped in "star" fashion so that one low tension terminal of each winding is connected to the star point O, and the other low tension terminal to the respective electrodes A, B and C. The two transformer secondary windings OX, OY are identical in output and voltage, but the secondary voltage OZ must be less than OX or OY. The voltage required of OZ varies with the resistance of the hearth. By means of an auto-transformer, or primary tappings incorporated in the transformer, the secondary voltage OZ can be varied until the currents in the primary supply phases are balanced, assuming that the currents through electrodes A and B are equal. By varying the voltage OZ the amount of current taken by the electrode C can be varied with only a slight displacement of the balance of the primary supply phases. This results in a passage of more or less current between the electrodes A, B.—*June 1st*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of seven of the patents given below £26 and on each of the remainder £18 have been paid in renewal fees.

No. 17,454/10.—Furnaces; charging. In connection with charging-hoists for shaft furnaces, when the closure for the furnace mouth does not return to its seating, a safety-device renders the hoisting mechanism inoperative by locking the starting-levers by putting the driving medium out of operation or by applying brakes. Benrather Maschinenfabrik Akt.-Ges., Germany. Dated July 22nd, 1909.

No. 17,525/10.—Ordnance; breech mechanism. Relates to devices for preventing the projectile from sliding out of the breech when the gun is elevated, and consists in providing a pair of overlapping pivoted pawls in the bottom of the breech, which remain inoperative until moved by the weight of the projectile. Krupp Akt.-Ges., F., Germany. Dated December 8th, 1909.

No. 17,749/10.—Treating grain, seeds, &c. A drum for airing or ventilating grain, seeds, and other materials comprises an annular perforated chamber closed at the ends and supported by rings on rollers. The apertures in the inner cylinder are circular, while in the outer they take the form of longitudinal slots. In each case the holes are tapered, having their smaller end next the annular chamber. The area of the air-inlet pipe is greater than the combined area of the apertures in the cylinder to ensure an even pressure and distribution, and the slots in the outer cylinder are as large as possible. Goettel, O., Germany. Dated July 26th, 1909.

No. 17,799/10.—Forge hammers. The spring beam or the like of a forge hammer is lubricated where it enters the eye of the sliding head by means of a cup which closes the eye, and is filled with grease by removing a screw stopper. This cup also protects the operator from splinters, &c., broken from the end of the beam. The ridges which work in guides are reduced towards the lower end to avoid jamming when that part of the head expands, owing to the heat or the action of swages attached by the dovetail recesses. Schmidt, R., and Rosenthal, H., Vienna.

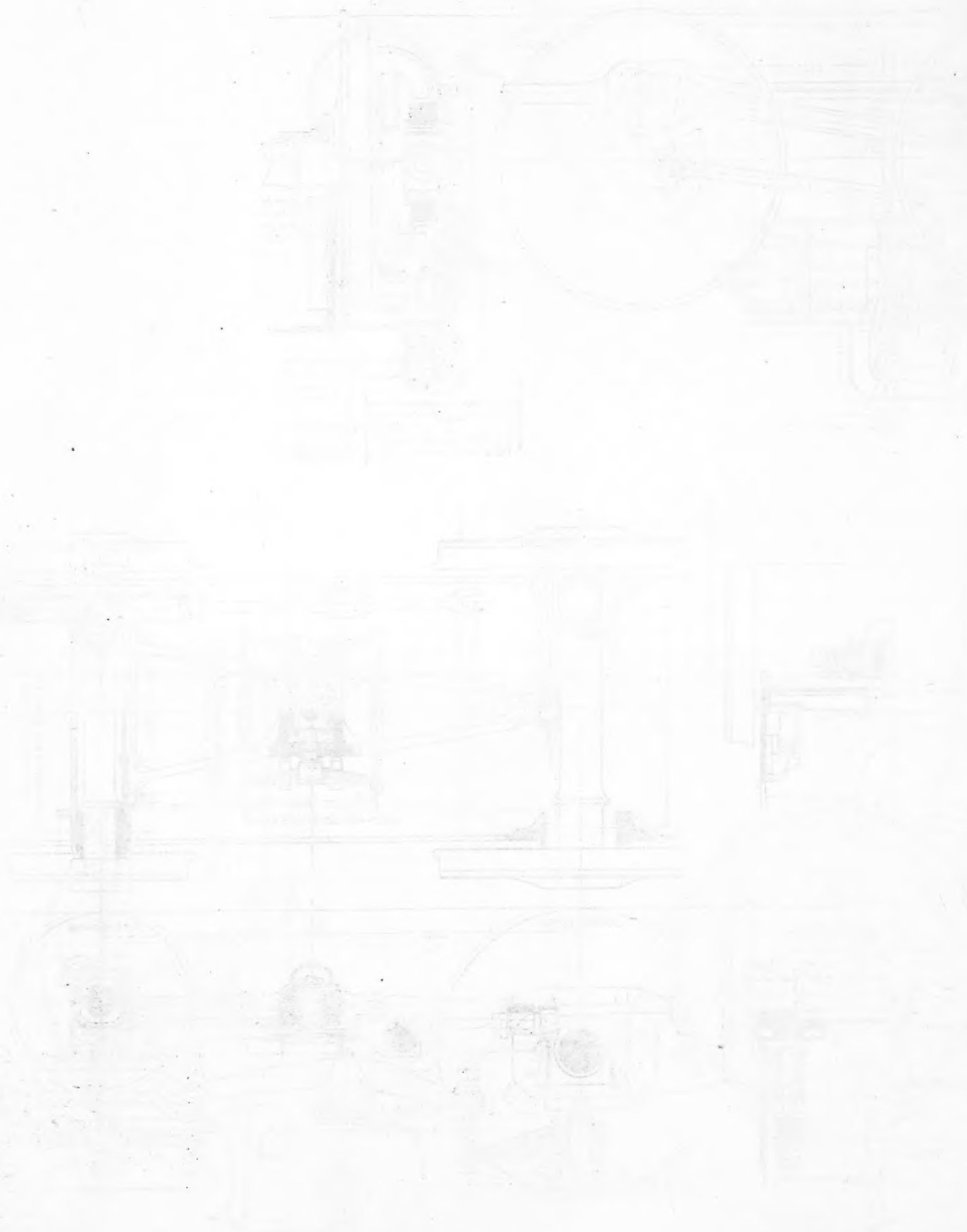
No. 17,809/10.—Oxygen. In self-heating mixtures for the production of oxygen, a by-component, such as an oxalate, for example, of iron or zinc, is employed, which decomposes, disengaging gas, when heated to near the melting point of the principal component, which is a chlorate or perchlorate, or a similar oxygen vehicle, or several such bodies. An example comprises potassium chlorate, iron, or manganese peroxide, powdered iron, and a little iron oxalate. Zeiss, C. (firm of), Germany. Dated July 29th, 1909.

No. 17,944/10.—Surveying instruments, &c.; sighting levels; spirit levels. In spirit levels having a reflecting system which projects images of the two ends of the bubble close together, the reflecting system is so arranged that the curves of the images present their concavities and convexities respectively in the same direction, so that the distance apart of the vertices of the curves serves as an indication of the position of the bubble, while changes in the length of the bubble do not affect the relative position of the images. Zeiss, C. (firm of), Germany. Dated August 5th, 1909.

No. 17,958/10.—Calculating apparatus; multiplying and dividing apparatus. A multiplying machine, in which the multiplication is performed directly by the depression of the multiplier key after the multiplicand has been set, is arranged so that a depression of the multiplier key actuates all the parts in turn and which, on being fully depressed, effects the registering of the products on the counting-wheels and the return of the parts to their initial position. Rauchwetter, F., Berlin.

No. 18,072/10.—Steam generators; feed water, supplying; alarms, low water. In a feed regulator wherein the feed valve is operated by a float in a chamber in communication with the boiler, the connection between the float spindle and the valve spindle is arranged in a casing placed between, and separated from, the float chamber and the valve casing. Schonicke, W., Germany. Dated October 5th, 1909.

No. 18,119/10.—Surveying instruments; sighting levels. Relates to instruments of the kind in which a reversible spirit level is employed, and the spirit level error is eliminated by taking a second reading with the ends of the spirit level reversed. Instead of the spirit level being detachably secured to the sighting telescope, it is fixed thereto, and the telescope is of the type which can be used in either direction. For this purpose, the eyepiece is adapted to slide on to either end. Zeiss, C. (firm of), Germany. Dated August 23rd, 1909.



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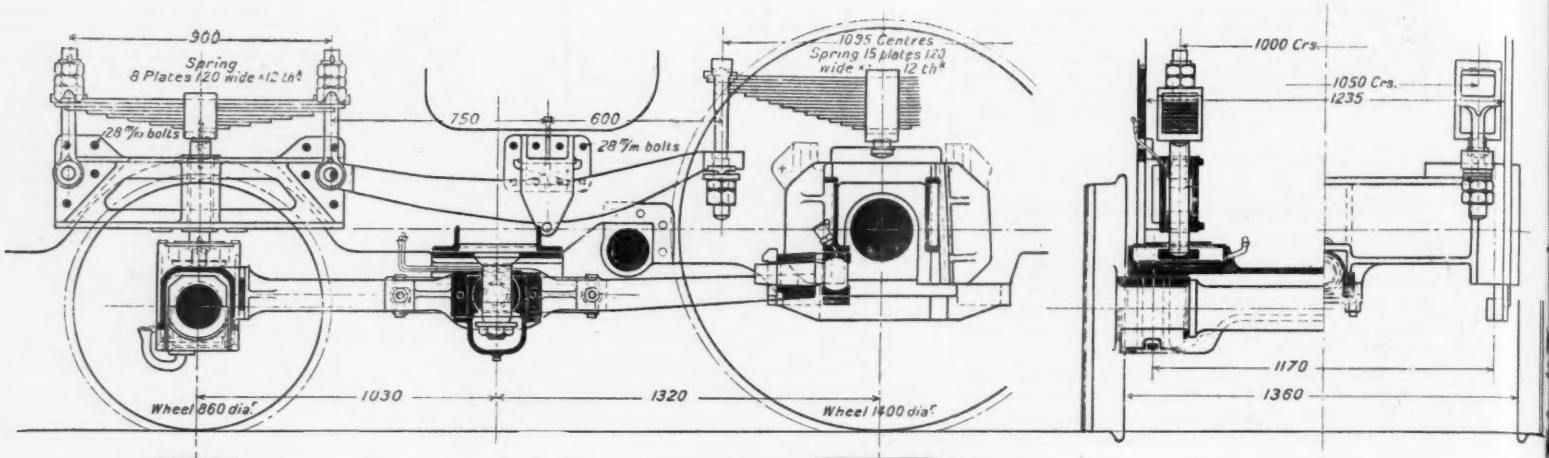

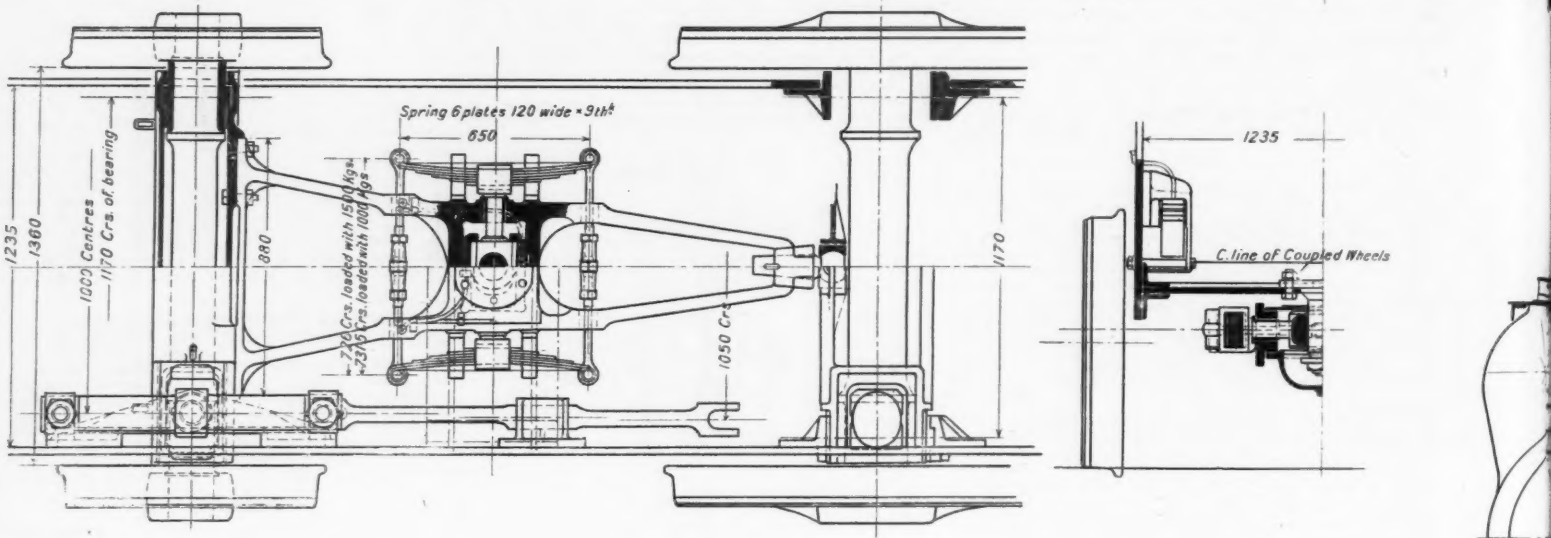

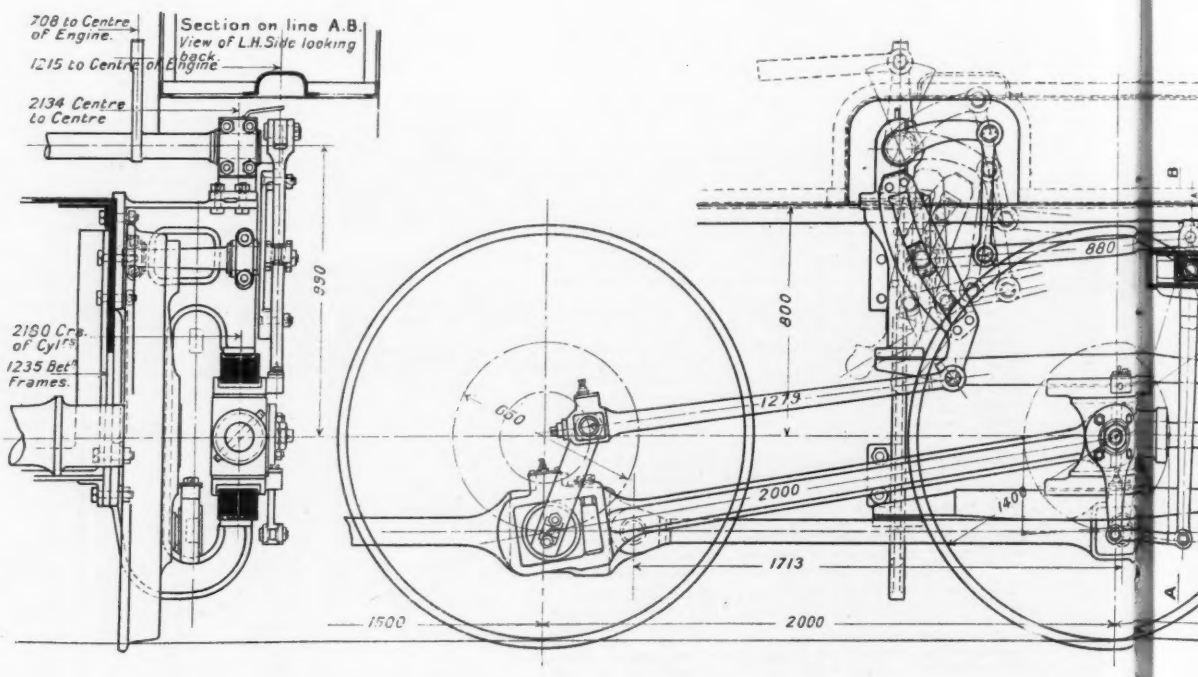

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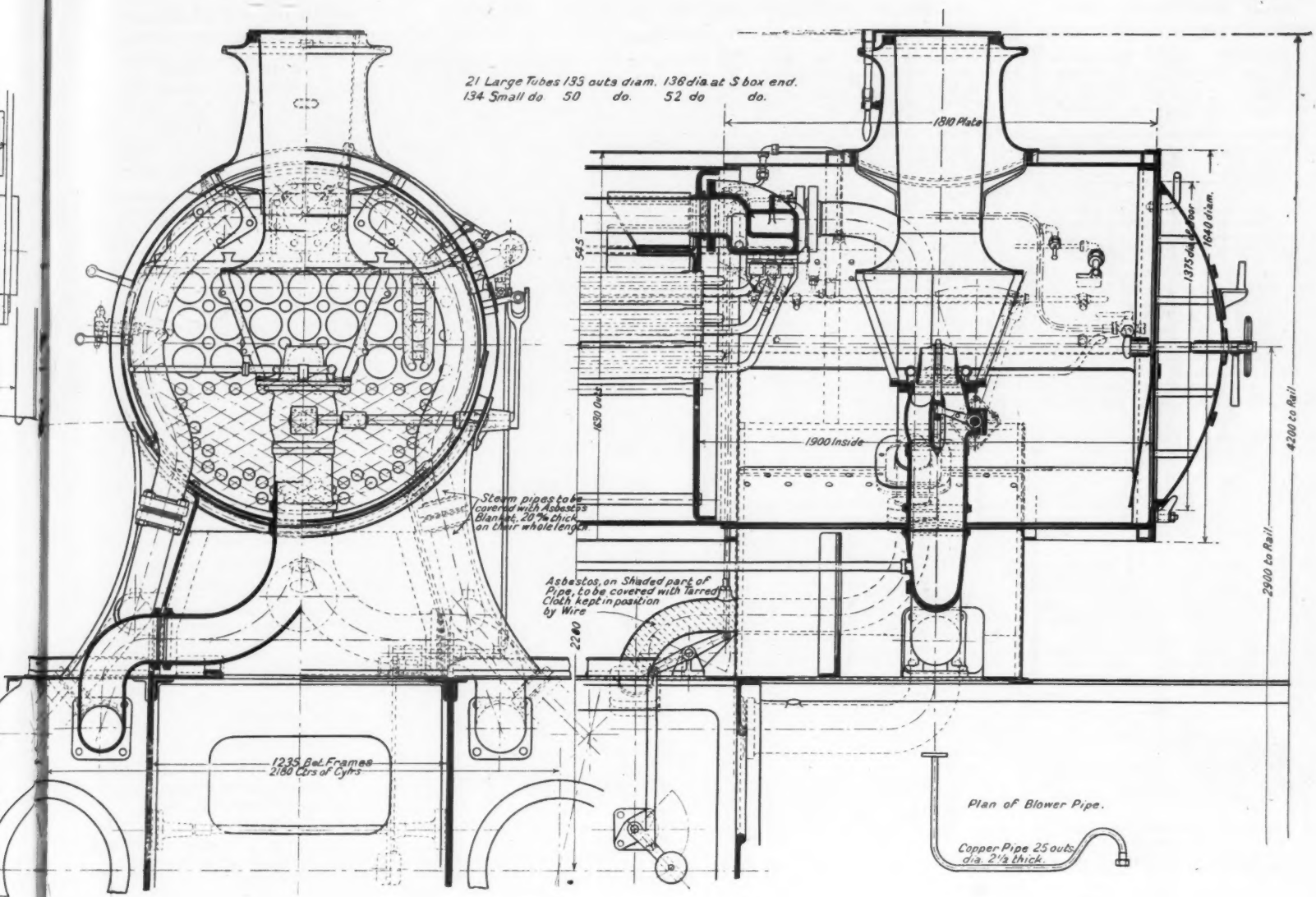
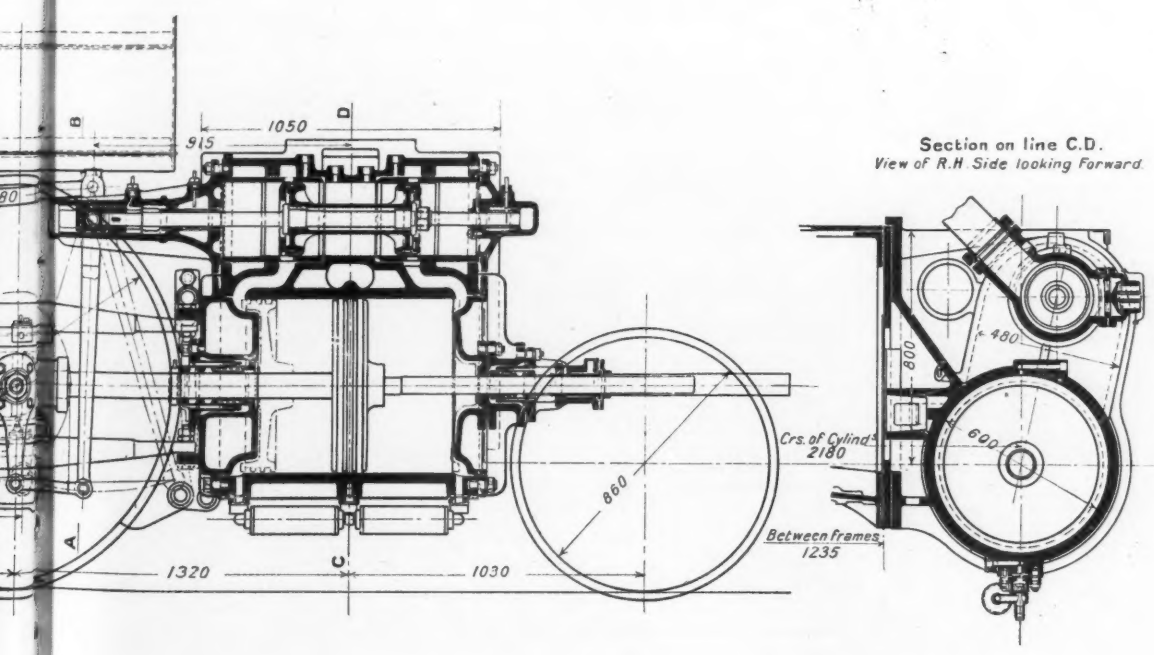
E COMPANY, LIMITED, GLASGOW, ENGINEERS


21 Large Tubes 135 outs diam. 138 dia at S box end.
134 Small do 50 do. 52 do do.
1810 Plate
545
1630 Outs
1900 Inside
1375 Inside Door
1640 diam.
4200 to Rail
2900 to Rail
Steam pipes to be covered with Asbestos Blanket, 20 m/m thick on their whole length
Asbestos, on Shaded part of Pipe, to be covered with Tarred Cloth kept in position by Wire
2240
1235 Bet. Frames
2180 Crs of Cyls
Plan of Blower Pipe.
Copper Pipe 25 outs. dia. 2 1/2 thick.



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SWAIN Sc.

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VOL. CXXIV.—No. 3212] LONDON: FRIDAY EVENING, JULY 20, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

PATENTS AND DESIGNS ACTS, 1907-1914.
AERIAL MACHINES.

The Proprietors of British Letters Patent No. 6265 of 1915 are prepared to SELL the PATENT or to LICENSE British Manufacturers to work under it. The specification relates to an aeroplane having an extension of the carrying wings at their flexible rear centre portion, said additional extension being warpable together with the flexible rear portion so as to change the curvature of the whole wing.
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The Corporation of Doncaster invite TENDERS for a WHEEL LATHE suitable for turning up Tramway Wheels. A second-hand Lathe will be considered if in good condition.—For particulars apply to the ENGINEER, Tramway Depôt, Grey Friars-road, Doncaster. 170 1

Wanted, a Works Engineer for works near London, engaged exclusively on Government work. Competent to take charge machinery, repairs and control labour. State salary, age, experience, and when available. No man at present employed on Government work will be engaged.—Address, 203, "The Engineer" Office. 203 A

Wanted, Man to Take Charge of ELECTRICAL PLANT, Wiring, &c., in large Engineering Works in Eastern Counties. State age, experience, and wages required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3380. 75 A

Wanted, Reliable Buyer and STORES MANAGER for Government-controlled Engineering Works in North London, manufacturing small electrical machines. Must be progressive and up to date in Stores control systems. Permanency for capable man.—Address, with full particulars of experience and salary required, 224, "The Engineer" Office. 224 A

A Firm of Engineers and Steel Founders can OFFER a good POST to really first-class business man with thorough knowledge of modern systems of Works, Sales, and General Office Organisation. Preference will be given to one with experience in the engineering or motor trade.—Write, stating qualifications and salary required, to Box 5910, c.o. A. J. Wilson and Co., Ltd., 154, Clerkenwell-road, London, E.C. 1. 228 A

Wanted, Assistant Works or WORKS MANAGER, of a progressive nature, thoroughly conversant with sheet and plate metal manufactures; good knowledge of press work, works organisation, and plant lay-out essential; a judicious disciplinarian; immediate or post-war engagement. Give full particulars, age, experience, qualifications, salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 108. 108 A

Assistant Engineer, Experienced in Blast-furnace and Steel Works Plant, WANTED for Steel Works in South Wales under Government control. Must be 6 o'clock a.m. man, ineligible for military service, and not already engaged on Government work.—Apply, stating age, qualifications, and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3439. 202 A

Assistant Works Manager WANTED IMMEDIATELY; good Machine Shop experience essential, for work of a high-class and accurate nature. State age, experience and salary required.—Box 4012, Haddon's Advertising Agency, Salisbury-square, London, E.C.4. 149 A

Chief Rate Fixer Required by Firm manufacturing Internal Combustion Engines and Motor Cars; must be capable of laying out Processes, fixing Rates, and estimating to Drawings on approved modern methods; good organiser essential; take entire charge Department. Only men of tried experience, strong character, and possessed of considerable tact need apply. Excellent prospects and generous salary for right man.—Address, 182, "The Engineer" Office. 182 A

Engineers Experienced in Esti- MATING Cost Prices of Machining Work WANTED.—Apply, D. F. A., Ministry of Munitions, Room 467, Hotel Metropole, London, S.W. 1. 217 A

Engineer Wanted who has had experience in Manufacture and Heat Treatment of parts of Pneumatic Tools, Rock Drills or similar accurate Repetition Work. Must be capable of taking complete charge of new shop. State salary required.—Audress, 189, "The Engineer" Office. 189 A

Experimental Engineer Wanted for Special Department used to designing Special Machinery. A good man would have rapid advancement.—Address, 151, "The Engineer" Office. 151 A

First-class Experienced Esti- MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Gas Engines and Suction Plant. —WANTED, ASSISTANT to Engineer-in-Charge. Must be competent to carry out Running Repairs. Good position to capable, trustworthy man.—Write, stating age, experience, and wages required, 188, "The Engineer" Office. 188 A

Production Engineer and Pro- GRESS CLERK.—WANTED, a competent MAN accustomed to supervising the progress and rapid production of aeroplane engines in process of manufacture in works employing 1500 hands.—Apply, stating experience and salary, to your nearest Employment Exchange, quoting "The Engineer" and No. A3445. No person already on Government work will be engaged. 207 A

Required, a Thoroughly Qualified MANUFACTURING ENGINEER, to assist in the management and control of 1000 to 1500 hands engaged in the production of aeroplane engines.—Give full particulars of experience and salary required to your nearest Employment Exchange, quoting "The Engineer" and No. A3444. No person already on Government work will be engaged. 206 A

Required by a Large Firm in N.W. London, engaged in the manufacture of Aero Engines, a capable and energetic MAN, to be responsible for Work Progress. Also an experienced MAN to arrange and control a Piecework System. State experience and salary required. No person engaged on Government work, or residing more than ten miles away, need apply.—Address, 177, "The Engineer" Office. 177 A

Required, Inspector to Take Charge of Viewing Shift, engaged on Government repetition work. Only a man with previous experience of fine limit work, who is a strict disciplinarian, need apply. State experience, age and wages required. N.W. district. No person residing more than 10 miles away or at present on Government work will be engaged.—Address, 200, "The Engineer" Office. 200 A

The Rhondda Engineering and MINING COMPANY, Limited, Cambrian Buildings, Cardiff, and their affiliated Company, Sheppard and Sons, Ltd., Ironfounders and Engineers, Bridgend, who are engaged upon work of national importance, REQUIRE the services of a competent Engineer to act as COMMERCIAL and GENERAL MANAGER for both concerns.
Applicants must have had commercial and workshop experience, preferably in connection with the sale and manufacture of Colliery Plants, particularly for treatment of coal.
Applications should be addressed to the SECRETARY, the Rhondda Engineering and Mining Co., Ltd., Cambrian Buildings, Cardiff, giving full particulars of age, experience, and salary required, accompanied by testimonials and references. 218 A

The Vacancy for Assistant Engi- NEER for large firm of Ironmasters and Colliery Owners in the Midlands (Box 360) is now FILLED. Applicants are thanked for their replies. 184 1

Young Engineer Wanted to carry out Installation of New Plant and to work same. Milling, Drilling and Hardening. Good opportunity of permanency as Working Foreman or Assistant Works Manager. Give full particulars, age, experience, qualifications and wages required. No person already on Government work will be engaged.—Apply to nearest Employment Exchange, quoting "The Engineer" and number 215. 215 A

Chemist, Metallurgical, Required to take control of Laboratory, both Physical and Mechanical. One thoroughly accustomed to Treatment of Steels and Research Work. London district. State age experience, salary required. No person resident more than ten miles away, or already employed on Government work, will be engaged.—Address, 230, "The Engineer" Office. 230 A

Chemist (Works), Used to Gen- ERAL Metallurgical Analysis. No person already engaged on Government work eligible.—Apply, stating full particulars to your nearest Employment Exchange, quoting "The Engineer" and reference No. A3336. 47 A

Representative Required Take charge of London Office of Provincial Engineering Manufacturers.—Full particulars of experience, age, salary, and testimonials to 134, "The Engineer" Office. 134 A

Wanted by Government Con- TROLLED Establishment in N.E. London district, several First-class DRAUGHTSMEN with Automobile experience. No applicant already employed upon Government work can be engaged.—Apply at your nearest Employment Exchange, quoting "The Engineer" and No. A3436. 193 A

Chief Draughtsman.—Wanted, thoroughly capable MAN, with General Engineering experience; must be good organiser, well up in modern workshop methods, and able to exercise efficient control over about 30 or 40 draughtsmen. Liberal salary to suitable man. No person already employed on Government work will be engaged. —Address, in confidence, stating fully experience, positions held, and age, 192, "The Engineer" Office. 192 A

Draughtsman Experienced in Internal Combustion Engines REQUIRED for Admiralty establishment. Preference given to one having knowledge of Heavy Oil Engines.—State age, salary required, details of previous experience, with approximate periods employed at each firm, and position, to Box No. 1166, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, London, E.C. 4. 191 A

Draughtsman, Junior, Mechan- ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3434. 12 A

Draughtsman (Head) Wanted, in controlled works, principally making Evaporators, Heaters, Filters and direct acting Steam Pumps for Admiralty. Salary to begin £300. State age and experience. No one employed on Government work can be engaged without consent of present Employers.—Address, P830, "The Engineer" Office. P830 A

Draughtsman, Mechanical, One used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 A

Draughtsmen and Erecting Engi- NEERS REQUIRED IMMEDIATELY, with knowledge of Ropeway Work preferred. (Munition and War Work only). State age, previous experience, salary required. No person already employed on Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 229. 229 A

Draughtsmen Required by Large controlled firm in the Midlands. (a) With experience of Machine Tool and Automatic Machine Design. (b) With experience of General Engineering and the Lay-out of Plant. Permanent positions for suitable men. No person engaged on Government work will be employed.—Apply, stating experience, age, salary required, and when at liberty, to your nearest Employment Exchange, quoting "The Engineer" and number 209 209 A

Draughtsmen Wanted, Tho- ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3296. 13 A

Jig and Tool Draughtsman Re- QUIRED for Aviation Works near London. Good man required. No person resident more than 10 miles away or already engaged on Government work need apply. State age, salary and experience.—Write, Bo 550, Samson Clark and Co., Ltd., 58, Great Portland-street, W. 1. 118 A

Several Draughtsmen Required immediately for urgent War Work. Experience in Crane and Dredger Work. No person at present on Government work will be engaged.—State experience, when at liberty, and wages required to your nearest Employment Exchange, quoting "The Engineer" and No. 3458. 235 A

Several Mechanical Draughts- MEN REQUIRED immediately for important War Work; also DETAILERS and TRACERS, with experience in Steam Plant, Conveying Plant, and general factory work. No person already engaged on Government work need apply.—State full experience, when at liberty, and wages required to your nearest Employment Exchange, quoting "The Engineer" and No. A3431. 173 A

Two Experienced Mechanical DRAUGHTSMEN, preferably with knowledge of internal combustion engine work, but not absolutely essential. Prospects good but not merely for duration of war. Applicants must be ineligible for military service. Government work. London district.
No person already employed upon Government work will be engaged.
Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P746. P746 A

Wanted, Assistant Tool Room FOREMAN for a large Government controlled establishment in the West Riding of Yorkshire engaged exclusively on Government contracts.
Applicants should have held a similar position in the tool room of a large works engaged on repetition work, and should be capable of controlling labour and taking entire charge when necessary, and should have had experience in the manufacture of small tools, jigs and fixtures.
No person already on Government work need apply.
Apply, stating age, full particulars of past experience, and salary required, to your nearest Employment Exchange, and quoting "The Engineer" and No. A3396. 121 A

Wanted for Large Engineering Works in Midlands, FOREMAN for brass Turning and Finishing Department; must be conversant with modern plant and repetition work. State age, experience, and remuneration required. No one on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3362. 76 A

A Large Engineering Company have a VACANCY for a first-class FOREMAN PACKER, who must possess an expert knowledge of the best methods of packing and protecting electrical machinery of all descriptions for foreign shipment. Good salary and permanent position to a suitable man. State age and experience. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3442. 205 A

Foreman Required to Take CHARGE of General Engineer's Shop; must have had previous experience.—Address, 198, "The Engineer" Office. 198 A

Required, Drilling Foreman for a small section engaged on Government work. To a man with experience of repetition Drilling Work, and who can get output, good wages will be paid. State experience and age. Permanent position if satisfactory. N.W. District. No person at present on Government work or residing more than 10 miles away will be engaged.—Address, 223, "The Engineer" Office. 223 A

Estimating Clerk Wanted for large works in the Midlands, producing Wrought and Cast Ironwork; permanent situation. Practical Works knowledge and previous experience in Costing essential. No person already on Government work will be engaged.—Apply, stating full particulars and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3238. 165 A

Chief Storekeeper Required for Aviation Works near London. Previous experience desirable, references required. No person resident more than 10 miles away or already on Government work need apply.—Reply, stating age, salary and experience, to 186, "The Engineer" Office. 186 A

Fitter - Driver Wanted for Engineers' Department, Factory on Government work. Good wages and permanent job to a competent man.—Apply, ENGINEERS, Finsbury Cabinet Works, Tottenham Hale. P818 A

Tool Room Turner Wanted; must be first-class man, used to backing-off Lathe and Screw Gauge Making for highly accurate tool work in connection with munitions. Good wages and permanent position to capable man.—Applicants, who must reside within ten miles, and not already on Government work, should call at ENGINES, Ltd., Tremmar-gardens, College Park, Willesden, N.W. 199 A

Agricultural Estates, &c.— Experienced practical Engineer SEEKS SITUATION. Diesel and other oil engines, gas engines, pumping plants, &c. Good references.—Address, P832, "The Engineer" Office. P832 B

B.Sc. (Glasgow) (25), Exempt, experience civil, electrical, and structural, DESIRES ENGAGEMENT.—Address, P816, "The Engineer" Office. P816 B

Buyer, Holding Responsible position in large Aircraft Works, SEEKS POSITION in similar capacity or as Manager; 11 years' extensive experience in Engineering and Aircraft Industries. Capable organiser. Highest references.—Address, P831, "The Engineer" Office. P831 B

Engineer (Now Abroad) Seeks MECHANICAL or RAILWAY APPOINTMENT; any part of world; four yrs. G.W.R., Swindon; marine and oil experience; five yrs. rubber, cotton, and tobacco in Tropics. Willing to proceed direct. Free December.—For particulars and testimonials, apply WALKEY, Canopus, Marazion, Cornwall. P794 B

Engineer (55), M.I. Mech. E., 25 years as works manager in small works to 150 employés, 20 years' experience with premium system of paying for labour, good experience in designing machines tools, and jigs therein, energetic, and life abstainer, is DESIROUS of CHANGE. Free any time. Permanency only considered.—Address, P821, "The Engineer" Office. P821 B

Mechanical Engineer (35), with works, drawing-office and commercial experience, DESIRES CHANGE. At present commercial manager at a works employing 350 men. Experienced in constructive organisation, estimating and tendering, stores and purchases, costing, and general production work; also experienced in metal merchanting and engineering agency business in London.—Address, P819, "The Engineer" Office P819 B

Works or General Manager for Automobile or General Engineering; wide experience in up-to-date machine, jig, tool and repetition work. Accustomed to organising and handling large staffs. Young and energetic, disengaged.—Address, P829, "The Engineer" Office. P829 B

Works Trained Practical Engi- NEER, who has for many years filled positions as Works Manager and Superintendent with good class firms, including three years' good experience in the production of Aircraft, R.A.F. and Private Designs, SEEKS POSITION of RESPONSIBILITY. A good organiser and thorough knowledge of works equipment.—Address, P828, "The Engineer" Office. P828 B

Young Man, Age 23, Three years on staff at important Blast-furnace Ironworks, finishing as assistant to general manager, and works experience, is OPEN to accept SITUATION in a similar capacity.—Full particulars, address, 213, "The Engineer" Office. 213 B

Wanted, Situation by Youth (16) in Structural Engineer's Drawing-office. 3 years' tuition at Borough Polytechnic.—Address, R, 50, Parker's-row S.E. 1. P823 B

Foreman Patternmaker (44) De- SIRES CHANGE; well up in general and high-class patternmaking. Good organiser, used to the control of men. —Address, 210, "The Engineer" Office. 210 B

Foundry Foreman, Practical Ex- PERIENCE in aluminium, iron, and brass, at present employed in a non-controlled shop, can OBTAIN RELEASE at any time.—For particulars, address, P824, "The Engineer" Office. P824 B

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Mechanic Desires Employment as Foreman or Supervisor, any district. Thoroughly used to control of labour. Work as fitter and turner if required —KEMP, 30, Gloucester Road, Bristol. 827 B

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PAGES II., III., LXXXII.
Numerical Index to Advertisements,
PAGE LXXXI.

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Wanted.—The Pioneer Electric CO., 22, Churchgate-street, Fort, Bombay (India), DESIRES CONNECTION with DEALERS in SECOND-HAND MACHINERIES—Electric, Boilers, Oil, Steam or Gas Engines, &c. P791 d

Agency.—Important Manufacturers of Gas and Oil Furnaces of scientific construction are open to ARRANGE AGENCIES for the Sale of their Specialities. Liberal terms and generous territorial appropriations. Individuals or firms with entrée to engineering interests should do lucrative business.—Apply, Box 12, The London Press Exchange, Ltd., 15, Strand, W.C. 2. 216 d

Agents.—A London Firm of Manufacturers, well established throughout the country, REQUIRE AGENTS for South-Eastern, Southern and South-Western Counties and Yorkshire. Applicants must be already in touch with engineers in the several districts.—Address, P822, "The Engineer" Office. P822 d

London Representation.—Advertisers have had 15 years' experience in Railway Rolling Stock Supplies and Plant for Colonial and Foreign Railways. Acquainted with the leading consulting engineers' requirements. AGENCIES for Specialities of particular interest to railways and the export trade generally WANTED either immediately or later on.—Address in confidence, 6, "The Engineer" Office. 6 d

Steel and Tools.—Agent Required for Scotland and Ireland by first-class Steel firm.—Address, 55, "The Engineer" Office. 55 d

Advertiser, with Useful Knowledge of Marine and Motor Engines, whose business has been seriously affected by the war, DESIRES to PURCHASE a WORKING PARTNERSHIP or INTEREST in an Engineering Business, preferably the manufacture of aeroplane or other engines or parts.—Apply by letter to G. S., care of Solicitor, 132, Seymour-place, Bryanston-square, W. 1. 201 c

Representative (47), Closely in touch with home and foreign Governments and railways, &c., for 25 years, WISHES to OBTAIN INTEREST in Firm who have SPECIALITY that they require introducing in this direction.—Address, F815, "The Engineer" Office. F815 c

Wanted for Government Order, THREE BOILERS, or EVAPORATORS, to be fired by coal. Each to evaporate about 11,000 lbs. water per hour from 200° F. Working pressure about 10 lbs. Higher pressure boilers acceptable if in stock, new or second-hand. Smaller units considered. Marine type preferred, but any considered.

Particulars of price, approximate weight, length, width, and height, to

ENOCK,
Thane Works,
South Tottenham, N. 15.

P820 f

Wanted, Generating Set, About 80 B.H.P., comprising Gas Engine, direct-coupled to compound-wound 6-pole generator, suitable for 220-250 volts, D.C.; gas engine to be driven off town gas. Must be in first-class condition and by approved makers.—Send full particulars to 195, "The Engineer" Office. 195 f

Wanted Immediately, First-CLASS 3-Ton or 5-Ton STEAM LOCO. CRANE.—Send full particulars, price, and where to be seen to 196, "The Engineer" Office. 196 f

Wanted, Large Salvage Centrifugal PUMP, about 12in., oil driven.—Send price, full particulars, to THOS. W. WARD, Ltd., Albion Works, Sheffield. 178 f

Wanted, Power Driven Rolls for Bending Angle Iron up to a maximum size of 3in. × 3in. × 3in. Machine requires to be reversible and capable of bending angles between radii of 6in. and 8ft.—Address, ROWNSON, DREW and CLYDESDALE, Ltd., 225, Upper Thames-street, London, E.C. 4. 179 f

Wanted, Steam Travelling CRANE, second-hand, in good order, or new, to lift three tons at 18ft. radius; suitable for 4ft. 8½in. gauge.—Address, 119, "The Engineer" Office. 119 f

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.E., Smith's Agency, Ltd., 100, Fleet-street, E.C 1 f

Wanted, Two 10in. Cyl. 4-Wheel Coupled LOCOMOTIVES, preferably by Barclay, Hunslet, or Hudswell-Clarke, in first-class working order.—Address, 194, "The Engineer" Office. 194 f

Profilers Wanted (New or Equal), take about 2ft. 6in. between housings, about 4ft. traverse; also one with two spindles, take about 5ft. to 6ft. between housings, about 8ft. traverse.—DOWNING, 12, Longbridge-road, Birmingham. 151 f

Required, for War Work, New or second-hand, in good condition, best possible delivery:—
One 20in. High-speed Electrically-driven DRILL (440 V., A.C.).
One 8in. or 9in. SLIDING, SURFACING and SCREW-CUTTING LATHE (Gap Bed).
One Electrically-driven MOTOR DISC GRINDER (440 V., A.C.).
One 13in. or 14in. SHAPING MACHINE.
One Light-running METAL CUTTING BAND SAW, with about 42in. pulley.
Quote, giving fullest particulars as to capacity and dimensions, to 183, "The Engineer" Office. 183 f

Several Electric Locomotives NEEDED, normal gauge, 550 volts, D.C., maximum width 7ft., fitted with 450 H.P. motors, and nearest size.—DIENY and LUCAS, 329, High Holborn, W.C. 1 (London). 211 f

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20 K.W. Engine and Dynamo WANTED, direct or belt-driven; 100-140 volts, for battery charging; good condition. Give price, particulars, and address for inspection.—EDWARDS and SHAW, Consulting Engineers, 105, Colmore-row, Birmingham. P825 f

Asbestos Packing, 30 Cwt., metallic, rubber cored, plain. Rounds and squares, 7-16 to 2in., 1s. 6d. lb. 35 Rolls RUBEROID ROOFING, 1ss. roll. Best offer clears.—A. B., 17, Ashmere-grove, Brixton, S.W. 2. P818 c

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12 tons, 2in. diam., 18ft. lengths.
Price £33 per ton, f.o.r. London.
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11, Queen Victoria-street,
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Bucket Dredge, Modern Manufacture, for SALE by Debtenure Holders; fitted with 4 cu. ft. buckets; digs 16ft. below water-line, stacks 10ft. above; steel hull of 3in. plates; 90ft. long, 30ft. wide, 5ft. deep; well hole in rear; fitted with suction gas engine; paid expenses on old sands yielding only 4½ oz. tin per cubic yard; easily converted for gold dredge; cost about £11,000; can be seen in England. Price £4000.—Apply, DEW, 8, Laurence Pountney-hill, London, E.C. 59 c

For Hire, Pumps and Well-BORING TOOLS for Contractor's Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London, S.E. Telephone No. 978 Hop. S22 c

For Immediate Delivery:— 10 good SECOND-HAND MAIN LINE WAGONS, 8-ton capacity.
Two good SECOND-HAND Six-wheels coupled SADDLE TANK LOCOMOTIVES, 13in. cylinders × 18in. stroke. Standard Gauge. Copper fire-boxes and steel tubes; about 11ft. wheel base. 120 lb. w.p.—Addres, 122, "The Engineer" Office. 122 c

For Sale:—

TWO Very Good BABCOCK and WILCOX BOILERS, insured for 200 lbs. working pressure, heating surface 1827 sq. ft. per boiler, with patent steam superheaters.

MIRRLEES - WATSON CONDENSER, with separator, but without pumps, 30,000 steam per hour, 3906 sq. ft. cooling surface.

One 600 K.W. GENERATING SET, Engines by Bellis and Morcom, Ld.; cyls. 16½ and 23in. × 42in. stroke "Parker" Generator, 500 volts D.C. Complete with surface condenser, motor-driven Pumps, &c.

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For Sale, Blowers, 7in. and 9in. All with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1703 c

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For Sale, in Excellent Running condition, GAS ENGINE, 120 H.P. on Producer Gas or 137 H.P. on Town Gas. PRESSURE GAS PRODUCER PLANT, 150 H.P., complete with Fan, Motor, Piping, &c. All by Crossley Bros.
Two DYNAMOS. 460 volts D.C., one 95 amperes, one 80 amperes, by Messrs. Crompton and Co.
DRIVING BELTS, &c. &c.
For inspection by appointment in London, address, 181, "The Engineer" Office. 181 c

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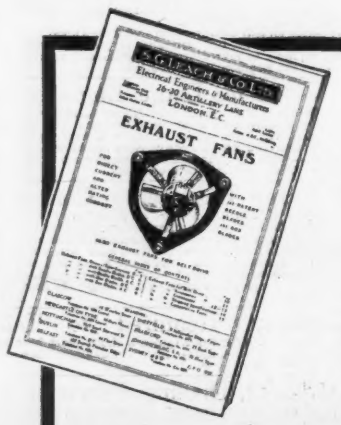

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THE LATENT HEAT OF STEAM.

By FRANK B. ASPINALL., M.I.E.E.

No. III.*

GENERAL REMARKS ON THE TRIALS.

Trial A.—After this trial was completed, experiments showed that the position of the three thermometers measuring the temperature of the condensing water must be altered when the temperature alters. The author had thought that the position of the thermometers was immaterial, as differences of temperature, and not actual temperatures were being measured.

Trials C and N.—The super-temperature suddenly disappeared, water was heard to come over, and the trap acted, showing that the boiler primed.

Trial H.—The super-temperature mysteriously disappeared in this trial, but the drain-pipe was afterwards found full of water, owing to the hole in the plug having become stopped during the trial. Possibly the injector action of the steam carried some water from the drain into the calorimeter pipe.

Trial S.—The superheater was drained before the trial commenced, but when the trial finished, it was found to be flooded. Possibly the boiler primed or the superheater had not been sufficiently warmed before the trial commenced.

The lowness in the trials at 100 lb. is probably due to experimental difficulties which were not present in the trials at 50 lb. and 150 lb. The pressure in the calorimeter pipe was 100 lb. just before it was dropped into the water, but when it reached its proper position under the water the pressure fell considerably, and before the pressure could be regulated a certain amount of steam passed which was not at 100 lb. pressure. In the trials at 50 lb. there was practically no drop of pressure, and in the trials at 150 lb. no drop at all. Though the steam was always superheated in the trials at 100 lb., so far as could be ascertained, great difficulty was experienced in regulating the room temperature, and as the super-temperature was extremely low, possibly the superheat disappeared for a short time without its absence being evident.

No effort was left unmade in all the trials to measure $t_1 - t_2$ correctly, as an error of .1 deg., or roughly 1 in 360, can make an error of 2 to 4 heat units, according to the weight of steam condensed. Though the mean value of $t_1 - t_2$ for all the trials is substantially correct, yet, in individual trials, there may be a possible error of 0.15 deg. either way. This is owing to the extreme difficulty of keeping such a large mass of water at exactly the same temperature throughout, and to the short time available for reading accurately the small differences of temperature. For instance, the top and bottom thermometers at the finish of a trial varied in some cases .25 deg., the average being about .15 deg., and actual trials at the surface of the water with three thermometers in different positions showed a variation of from .025 deg. to .075 deg. Another source of possible error was that it was not always the top thermometer which read the highest temperature, and the three thermometers did not reach their maximum temperature at the same time. Again, when steam was shut off, the temperature rose steadily to commence with, but then made a sudden rise of from .025 deg. to .1 deg., which lasted only about two seconds in the trials at 100 lb. and 150 lb. Stirring would have enabled the temperature to be read more accurately, but this would have probably caused an error due to radiation greater than that involved in averaging the thermometer readings.

Even although extreme care was taken to prevent the steam from containing water just before it was wiredrawn, the small super-temperature obtained for such a large drop in pressure shows that water must have been present. There seems no other explanation than to conclude that water can be present in steam in some form which is not a mechanical mixture. This view also seems to be confirmed by the fact that, for equal differences of pressure, higher super-temperatures were usually obtained at 50 lb. than at 100 lb., which apparently shows that steam at a higher temperature can contain more water than at a lower temperature like common air.

The experiments seem to support the conclusion that steam has a dew point like air.

Specimen Data.

No.	Important data.	Data.	50 lb. gauge pressure. Fixed pipe. D. 15/2/10.	50 lb. gauge pressure. Swivelling pipe. I. 10/3/10.	100 lb. gauge pressure. Swivelling pipe. N. 2/5/10.	150 lb. gauge pressure. Swivelling pipe. T. 2/6/10.
1	—	Weight of wooden vessel thoroughly dried. Thermometer guards in position. Pounds	158.968	158.968	158.968	158.968
2	—	Weight of metal in vessel reduced to water. Plugs in gland omitted. Pounds	1.089	1.089	1.089	1.089
3	—	Water value of wood in vessel by actual measurement. Pounds	—	36.62	36.62	36.62
4	—	Weight of vessel and condensing water at commencement of trial. Thermometers in position. Pounds	1184.75	1178.12	1184.37	1184.43
5	—	Actual weight of condensing water at commencement of trial . Pounds	1025.78	1019.152	1025.407	1025.462
6	W	True water value of condensing mediums. Pounds	1026.87	1056.861	1063.116	1063.171
7	—	Weight of vessel and condensing water at finish of trial. Thermometers in position. Pounds	1207.31	1212.12	1215.87	1219.75
8	w	Weight of steam condensed. Pounds	22.56	34	31.5	35.32
9	—	Time during which steam was blown into condensing water. Minutes	23	31	18	17
10	—	Average boiler pressure. Gauge checked by deadweight. Pounds per square inch gauge	93	96.2	140.5	148.75
10a	—	Temperature of steam at the average boiler pressure	333	335.1	360.8	—
11	—	Pressure of steam in calorimeter pipe. Pounds per square inch gauge	50	50	100.	148.75
12	T	Temperature equivalent to the pressure in calorimeter pipe. Thermometer V., No. 577,673. Deg. Fah.	297.8	297.8	337.4	365.1
13	—	Mean actual corrected temperature in calorimeter pipe. Thermometer V., No. 577,673. Deg. Fah.	301.0	301.4	339.2	365.2
14	—	Mean super-temperature in calorimeter pipe. Deg. Fah.	3.2	3.6	1.8	.1
15	—	Specific heat of superheated steam at the pressure in calorimeter pipe	.52	.52	.6	.65
16	—	Actual superheat in steam in calorimeter pipe. B.T.U.	1.66	1.67	1.08	.06
17	—	Area of lagged radiating surface in calorimeter pipe. Thickness of lagging, 1¼in. per square foot	.80	.80	.80	.80
18	—	Heat radiated per pound of steam if .3 B.T.U. are radiated per square foot per 1 deg. difference of temperature per hour. B.T.U.	.90	.80	.70	.53
19	—	Area of unlagged surface of calorimeter pipe. Square feet	.31	.31	.31	.31
20	—	Heat radiated per pound of steam if 2.7 B.T.U. are radiated per square foot per 1 deg. difference of temperature per hour	3.28	2.8	2.45	1.85
21	—	Average temperature of room during trial. Thermometer IV., No. 577,680. Deg. Fah.	67.5	72.8	72,6	82.4
22	—	Temperature in calorimeter pipe above room temperature. Deg. Fah.	233.5	228.6	266.6	282.8
23	—	Total heat radiated from lagged and unlagged pipe per pound of steam condensed. B.T.U.	4.18	3.6	3.15	2.38
24	j	Difference between the mean superheat in the steam and heat lost by radiation. + or −	+2.52	+1.93	+2.07	+2.32
25	t_2	Mean observed corrected initial temperature of the condensing water. Thermometers I., 577,675; II., 577,676; III., 577,678. Deg. Fah.	53.81	54.2	55.31	62.96
26	—	Lowest temperature which could be read owing to position of thermometers in gland when 25 obtained	52	54.0	55.0	62.5
27	—	Mean observed corrected final temperature of condensing water. Same thermometers as in 25	79.65	91.68	89.98	103.03
28	—	Lowest temperature which could be read owing to position of thermometers in gland when 27 obtained	77	91.0	89	103
29	—	Temperature of condensing water below room temperature. Deg. Fah.	13.69	18.6	17.29	19.44
30	—	Temperature of condensing water above room temperature. Deg. Fah.	12.15	18.88	17.38	20,63
31	—	Temperature gained by condensing water when below the room temperature. Deg. Fah.	.02	.04	.05	.03
32	—	Temperature lost by the condensing water when above the room temperature. Deg. Fah.	.06	.39	.31	.51
33	—	Difference between temperature lost and gained by the condensing water. Deg. Fah.	.04	.35	.26	.48
34	t_1	Final temperature of the condensing water if no heat had been lost or gained. Deg. Fah.	79.69	92.03	90.24	103.51
35	—	Time before room temperature reached by condensing water. Minutes	—	15	9	8
36	—	Time after room temperature reached by condensing water. Minutes	—	16	9	9

Summary of Trials.

Nature of trial.	No.	W.	$t_1 - t_2$.	w.	T − t_1.	Regnault's. T − t_1.	J.	Latent heat.	Trials in which no error was apparent.	Trials believed to be within + or − .8 per cent. of true total heat.	Latent heat. Regnault's formula, or the heat latent in the steam before it was dried.	
Trials at 50 lb. per sq. in. gauge. Accepted value for the latent heat of steam at this pressure, 905.	*a*	1035.741	38.01	34.53	199.35	234.08	+2.95	943.723	—	—	906.045	Thermometers set wrong.
	b	1028.491	40.37	35.25	203.32	241.42	+1.65	976.207	976.207	976.207	936.46	
	c	1031.12	42.21	38.25	201.31	234.31	+3.16	939.721	—	—	903.56	Superheat lost, due to priming.
	d	1026.87	25.88	22.56	218.11	253.31	+2.52	962.397	962.397	962.397	924.68	
	e	1025.62	46.38	40.75	197.42	231.42	+2.56	972.45	972.45	972.45	938.41	
	f	1063.491	42.11	38.00	203.24	240.84	+0.91	976.186	976.186	976.186	937.68	
	g	1065.549	32.69	29.62	209.41	231.61	+3.89	970.469	970.469	970.469	944.38	
	h	1055.639	54.05	50.41	190.05	208.85	+3.35	945.164	—	—	923.01	Superheat lost, drain afterwards found stopped.
	i	1056.861	37.83	34.00	205.77	243.07	+1.93	972.073	972.073	972.073	932.84	
	j	1063.049	48.57	43.81	199.85	234.05	+2.24	980.940	980.940	980.940	944.98	
	k	1058.361	37.65	34.00	210.87	251.37	+3.6	964.709	—	—	920.59	Trial run without measuring the temperature of the steam to see if it was safe to trust to the pressures.
Trials at 100 lb. per sq. in. gauge. Accepted value for the latent heat of steam at this pressure 875.75.	*l*	1062.99	36.71	32.37	244.53	268.53	+2.28	963.260	963.260	963.260	936.98	
	m	1061.861	35.51	31.44	246.14	267.84	+1.58	954.76	954.76	—	931.48	
	n	1063.116	34.93	31.5	247.16	270.56	+2.07	933.78	—	—	908.32	Superheat lost, due to priming.
	o	1063.178	32.22	28.43	248.63	278.03	+2.86	959.14	959.14	959.14	927.56	
	p	1056.801	40.73	36.06	242.79	268.89	+2.68	953.55	953.55	—	924.80	
	q	1059.421	36.48	32.00	245.37	273.67	+2.64	965.01	965.01	965.01	934.07	
Trials at 150 lb. per sq. in. gauge. Accepted value for the latent heat of steam at this pressure, 855.33.	*r*	1064.051	29.19	25.00	273.21	—	− .43	968.74	968.74	968.74	Formula does not apply.	Superheat lost, due to priming
	s	1063.92	37.59	33.32	264.76	—	+2.56	938.12	—	—		
	t	1063.171	40.55	35.32	261.59	—	+2.32	961.33	961.33	961.33		
	u	1066.11	39.44	33.75	261.98	—	−6.25	977.61	977.61	977.61		
								MEAN.	967.56	969.67	True value 970.4	believed to be between 970 and 971—say,
								50 lb.	—	972.96	If 970.4 accepted	error in total heat, + 2.56 in 1236.3, .207% +
								100 lb.	—	962.47	„	„ „ − 7.93 in 1275.8, .62% −
								150 lb.	—	969.22	„	„ „ − 1.18 in 1304.0, .09% −

* No. III. appeared July 13th.

The following are examples of the super-temperature obtained :—

Steam wiredrawn. Pounds.	Super-temperature at 50 lb. Deg.	Super-temperature at 100 lb. Deg.
42	3.6	1.9
45	2.4	.4
54	6.6	.9

It will be noticed that, when the steam in the trials at 50 lb. and 100 lb. abs. was at the boiler temperature and pressure, the quantity of heat present was more than the quantity of heat which could be present according to Regnault's empirical latent heat formula ; that is, this steam was drier steam than the steam to which Regnault's values apply.

RESULTS OBTAINED BY DIFFERENT OBSERVERS.

Latent Heat at Atmospheric Pressure.

Despretz	972	Mean 970.40
M. Brix	972	
Regnault	966	
Henning	970.66	
Joly	969.87	
Aspinall	971.9	

The value 970.4 was taken as the base when deciding which values ought to be rejected as unreliable, when working out the mean value for the latent heat, as the author did not consider it advisable to take the Blackheath value 970.13.

The Finsbury value for the latent heat of steam, or the exact quantity of heat required to convert water from the form of water completely into the form of steam, at the same temperature and pressure as the temperature and pressure of the water converted into the steam, is 969.67 B.Th.U., a constant per 1 lb. of steam.

CONSTANT LATENT HEAT.

The author declares his value for the latent heat of steam = a constant as 969.90, this being the mean of the Blackheath value 970.13 and the Finsbury value 969.67 ; that is, it always requires 969.90 B.Th.U. to convert 1 lb. of water completely into 1 lb. of steam, no matter how the pressure varies.

These are the facts to be emphasised :—

When the steam was on the boiler side of the calorimeter stop-valve, or when water was mixed with the steam, the heat latent was found to be a variable.

When the steam had been wiredrawn to convert it into superheated steam, or when absolutely no water was mixed with the steam, the heat latent was found to be a constant ; that is, when the heat latent was the maximum heat which could possibly be latent, or latent heat, it was a constant.

This is the difference between Regnault and the author at above atmospheric pressure.

Regnault measured the heat which, by chance, happened to be latent in a certain portion of his boiler steam. The author measured the maximum heat which could possibly be latent, or latent heat.

On the completion of the Finsbury determination the evidence was again examined.

These are the basic laws :—

It is the quantity of water present, and not the temperature present, which determines the quantity of heat which is latent.

The quantity of heat latent is a constant if no water is present.

The quantity of heat latent is a variable if water is present, because the maximum quantity of water which can be present increases as the pressure increases.

James Watt corrected for the water present when working at atmospheric pressures, and dried his steam as it was produced at below atmospheric pressure.

Southern and the author dried the boiler steam after its production, and then measured the heat latent in the dried boiler steam.

The two cycles stated by Carnot, and what he declares to be "the fundamental basis of all heat engines," depend for their truth upon latent heat as defined being a constant.

The Carnot function and the Carnot cycle depend for their truth upon latent heat as defined being a variable.

Carnot was altered because he contradicted various mathematical theories based upon Regnault's empirical latent heat formula.

Regnault, before making his measurements, assumed that it is the temperature which determines the quantity of heat latent ; that is, the heat which can be latent at the same temperature is a constant, and the heat which can be latent at different temperatures is a variable.

James Watt and Southern, who were practical engineers, knew that variously wet, dry and variously superheated steam could exist at the same temperature, but apparently this fact was not known to physicists and mathematicians, when Regnault published his memoir.

Regnault, owing to his erroneous assumption, used an indeterminate formula, which gave any quantity of heat which might be latent owing to water being present, and even superheat, as the latent heat of steam.

Regnault made three distinct sets of measurements at, at above, and at below atmospheric pressure, and in each set what he accepted as the latent heat of steam was different, and was not latent heat as defined.

At atmospheric pressures he measured the total heat in superheated steam, at some unascertained temperature, and at some unascertained pressure below the existing atmospheric pressure, so the heat actually latent was the constant quantity. But what he accepted as the latent heat was the quantity of heat which would have been latent if, instead of the steam being superheated, it had been wet steam, at the temperature deduced from the barometer, at the existing atmospheric pressure, and had carried the same heat as the superheated steam carried.

At above atmospheric pressure he measured the total heat in very low pressure superheated steam, which was always nearly at the same pressure ; no matter how the boiler pressure increased, the quantity of superheat present increasing as the boiler temperature increased, so the heat actually latent was always the constant quantity. Neither the temperature nor the pressure of the calorimeter steam was ascertained. But what he accepted as the latent heat was the quantity of heat which, by chance, happened to be latent in the portion of wet boiler steam, which, when wiredrawn, produced the low-pressure superheated calorimeter steam. The wetness of his boiler steam increased as the pressure increased.

At below atmospheric pressure he lost some of the water produced by condensing the steam, owing to the way in which he broke the vacuum. He therefore did not measure the total heat in his superheated calorimeter steam, which was low-pressure steam below the boiler pressure, with a decreasing superheat as the boiler temperature decreased. The heat latent in his calorimeter steam was always the constant quantity. Owing to his losing water, what he accepted as the latent heat was the heat latent in the portion of wet boiler steam, which produced the superheated calorimeter steam, which produced the water found in the calorimeter worm on the completion of a measurement, plus the heat latent and a portion of the sensible heat, in the portion of wet boiler steam, which, when wiredrawn, produced the portion of the superheated calorimeter steam, which produced the portion of water blown back into the boiler steam space when the vacuum was broken.

Regnault did not know that his calorimeter steam was low-pressure superheated steam, firstly, because he produced an artificial atmosphere of air at the boiler pressure in his calorimeter, owing to the then existing belief that the natural atmosphere played some part in the production of steam ; and, secondly, because it was not then known that steam can become superheated when expanded on no load.

The accepted volumes depend for their truth upon Regnault's empirical latent heat formula.

The absolute zero temperature depends for its truth upon latent heat as defined being a variable, and the value depends for its truth upon Regnault's empirical latent heat formula.

Fairbairn and Tate measured the density of steam as defined when working at above 25 lb. abs., and the density of mixtures of steam and water when working at below 25 lb. abs. They did not directly ascertain the temperature at which their steam became superheated, but calculated it from the calculated volumes, so, at above 25 lb. abs., their steam was superheated when they believed it to be superheated, and at below 25 lb. abs. their steam was wet when they believed it to be superheated.

The author set out, 27 years ago, to find the missing quantity ; it is simply a mathematical error due to the calculations being based upon inaccurate volumes.

The facts recorded below provide material on which to form an opinion as to the true values of the two constants.

James Watt distinguished between latent heat and heat latent. All the trouble has arisen owing to Regnault not making this distinction.

PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT.

By GEORGE KENWORTHY, Asso. M. Inst. C.E.

No. III.*

SECTION II.

USES OF MATERIALS.—ADVANTAGES OF WROUGHT IRON.

WROUGHT iron plates and rolled sections are even now largely used for iron barges, boats, and dock gates ; but iron has generally been ousted out for bridge building and general structural work. The reason why iron is still retained for water work is that it is far less susceptible to corrosion than mild steel, which, unless kept particularly well painted,† quickly perishes through the effects of rust. Similarly, iron is used in gate and ornamental railing work, where durability is essential. Iron has another advantage over mild steel, which is perhaps little known. It is found by experiment—on W. and T. Avery's impact testing machine—that it resists impact blows better than mild steel, and it is suggested here that the parts of structures where impact makes itself mostly felt should be made of this material.

Wrought iron plates and large sections are difficult to procure at the present time, and though, not many years since, the position was just the reverse, the price of wrought iron is now considerably higher than that of mild steel, at least for all the larger sections. The demand for mild steel and the difficulty of procuring wrought iron is due in part to the higher tensile strength of the former, and also to the difficulty of working the puddling process. If wrought iron came into favour again for bridgework, as in the earlier days, more modern methods might be found for working the iron, so that it could still take its place in the bridge and structural trade, and the price be made to compare favourably with that of its rival.‡

Assuming that the stress due to live load in different parts of a bridge or structure is increased by impact in a proportion equal to $\frac{300}{L + 300}$, where L is the length in feet of that part, then the live load stresses in stringers and cross girders of a bridge will be increased from 90 per cent. to 95 per cent. by impact allowances. In fact, it is quite usual to double the calculated live load stress—which is practically the only stress in these members—in cross girders, stringers, and crane girders. It would seem, then, that the cross girders and stringers of a large bridge might be made of wrought iron with advantage and economy, whilst the main girders, where the impact effect is much reduced, could be made of mild steel. Introducing two classes of material into large structures is not unknown—as, for instance, in the new Quebec bridge, where nickel steel is used in the principal members. This special steel has a greatly enhanced strength, and the deadweight of the large members is very considerably reduced.

Assuming that in the flanges of a cross girder the calculated live load stress = S_1.

The allowable stress if steel were used = $6\frac{1}{2}$ tons per square inch.

The allowable stress if iron were used = $5\frac{1}{2}$ tons per square inch.

All the available values for Latent Heat as distinct from Heat Latent. Weight of Steam varying from grains to thousands of lbs.

No.	Pounds absolute.	Observer.	Latent heat as distinct from heat latent.	Accepted for latent heat.	Error if 970.00 accepted as true value.	Remarks.
1	1 approximately.	Two condensers.	969.71	1043.02	− 0.29	
2	3.4 mean.	James Watt.	977.30	—	+ 7.30	
3	14.7	Mean of six observers.	970.40	966.07	+ 0.40	5 + errors.
4	19.7	Author.	970.65	—	+ 0.65	5 − errors.
5	34.7	Author.	967.84	—	− 2.16	
6	39.2	Southern.	974.00	—	+ 4.00	
7	58.8	Southern.	961.00	—	− 9.00	
8	64.7	Author, Finsbury.	972.96	—	+ 2.96	
9	114.7	,,	962.47	—	− 7.53	
10	164.7	,,	969.22	856.2	− 0.78	

Mean .. 969.54.

Values by Different Observers for Latent Heat as Defined.

James Watt	Value 968.65		969.23
Southern	,, 967.50		
Mean at atmospheric pressures	,, 970.40	970.00	
Two condensers	,, 969.71		
Author	,, 969.90		

The above evidence appears to support the view that the heat latent, when absolutely no water is present, or the latent heat of steam, is nearly, if not actually, 970 B.Th.U. at all pressures.

All the Available Values for P × V = a Constant.

	P, *Pounds Absolute.*	V, *Cubic Feet.*	
Southern's	Value 398.97		399.89
Fairbairn and Tate's	,, 400.87		
Molecular weight	,, 399.84		

The above evidence appears to support the view that, provided absolutely no water and absolutely no superheat is present, the pressure multiplied by the volume is always nearly, if not actually, 400,

Cost of mild steel = C *s*.

Cost of wrought iron = C *i*.

Assume also that 100 per cent. allowance is necessary for impact with mild steel, and that 50 per cent. allowance is necessary for impact with wrought iron. The cost of the wrought iron material required would then be

$$= S_1 \times \frac{150}{5\frac{1}{2}} \times C\,i = 27.3\,S_1\,C\,i.$$

The cost of the mild steel

$$= S_1 \times \frac{200}{6\frac{1}{2}} \times C_s = 30.7\ S_1\,C_s.$$

* No. II. appeared July 13th.

† The relative resistance of iron and steel to corrosion is still a debatable point.—ED. THE E.

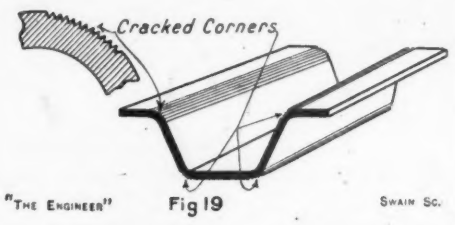
‡ For over forty years attempts have been made to introduce mechanical puddling into this country, and the Board of Education have quite recently referred the matter to the British Ironmasters' Association who have appointed committees to deal with the subject, offering reward for original ideas and suggestions.

Assuming further that the cost of the iron and steel is brought down to the same level, we have:—That the cost of the iron girder would be to the cost of the steel girder as 27.3 is to 30.7, or that the steel cross girder would be 12 per cent. more expensive than the same girder if it were made of wrought iron. The above figures cannot be taken as conclusive in themselves, but they go to show that the use of wrought iron sections should be carefully investigated, and experiments made and tabulated, showing what the actual relationship is between the two materials, particularly in regard to the way they both resist impact blows.

GRAIN IN IRON AND STEEL.

It is unnecessary to point out that there is a certain grain in the material of iron and steel produced by the passage through the rolls, and that this grain runs in the same direction as that in which the plate or bar has passed through the rolls, also that, generally speaking, the "way of the grain" is in the direction in which the greatest ultimate stress can be withstood. This is particularly so with wrought iron, due partly to the faggot system of manufacture, and partly to the nature of the material itself, which does not allow the same drawing out or extension in the rolls as mild steel, and, consequently, the material never becomes so thoroughly homogeneous. A steel bloom actually gets hotter, due to the work done on it in rolling; but this is not so with iron, or, anyway, not to the same extent, and the iron quickly loses its heat.

Professor Perry draws attention to the effect of grain, and points out that it is evident in mild steel, though in a less degree than in wrought iron. Morgan W. Davies, in his valuable treatise on "Bridge Design," says that if iron is used across the grain its strength is only about 65 per cent. of its value in the other direction. It is usual for specifications also to insist that "The fibres of all steel work are to run in the direction of the greatest stress, and all covers must be cut from plates of the widths shown, to ensure this" (Crown Agents). As a matter of fact, these stipulations are almost entirely overlooked, not only with mild steel, but also with wrought iron. If material is ordered without stating which



way the grain is required to run, it may be taken for granted that it will be rolled at the mills, so that the longer way of the plate is the "way of the grain."

Now, it is quite conceivable that in many cases the direction in which it is required to take up the greatest stress is not the longer way of the plate. Therefore, unless the way in which the plate is required to be rolled is stated on the order to the mills, which is practically never done in ordering mild steel plates, then the specified ideal conditions are not realised. But it is curious to note that so far as mild steel is concerned the trade custom of ignoring the direction of grain is justified.

From tests made for the Board of Trade on mild steel plates manufactured by the Dalzell Steel and Ironworks, the following figures, taken from their handbook, go to prove that the grain effect is practically negligible, and, moreover, that in the majority of instances tabulated, a different result altogether from that anticipated is obtained:—

Test number.	Thickness in inches.	Elastic strength in pounds per sq. in.		Ultimate strength in pounds per sq. in.	
		With grain.	Across grain.	With grain.	Across grain.
1996–7	.36	29,800	33,300	62,405	62,940
1999–0	.36	33,800	33,900	64,720	66,370
2017–8	.70	31,900	29,300	60,415	60,570
2014–5	.73	28,100	33,800	60,570	62,435
2032–3	.96	26,700	28,200	57,205	57,680
2035–6	.97	31,300	29,900	59,320	59,865

Thus it will be seen that in the whole series of tests given the ultimate strength is even greater across the grain than with it, though in two cases the actual strength up to the elastic limit is greater with the grain than across it. The probable explanation is that the strength of mild steel plates is governed chiefly by the amount of work applied to the material when rolling, and to the amount it is turned about and cross-rolled whilst being manufactured.

But if with mild steel the grain can be neglected, it is not so with wrought iron, and makers using both materials fall into the error of treating them both alike. Consider, for instance, the effect of grain in the manufacture of trough flooring required for use in the deck of a jetty. As mentioned earlier, it is usual to specify the use of iron in pier and jetty work on account of corrosion. Supposing the floor is supported on girders, 6ft. apart, then the troughs may be only 6ft. long. If the length were not much greater than this, it would be quite possible to roll the plates with the grain in either direction.

Now, iron is difficult to bend for troughing, even when the material is of good quality, and the plates have been well heated in the furnace before bending. If the grain is made to run lengthwise, *i.e.*, the 6ft. way, of the plate, the troughs will probably show bad cracks at the corners after bending, as shown in Fig. 19. If, however, the plates were rolled in the other direction, with the grain running across the way of bending, an apparently much better result would be obtained, and there would be no obvious defects.

A manufacturer's point of view is that an apparently good-looking job must be made; but from a theoretical standpoint the defects of the cracked corners in the first case are nothing to compare with the weakening of the whole trough by the grain running in the wrong direction. Whatever the advantages are regarding manufacture, the cross running of the grain should never be allowed for flooring where the troughs take the place of girders spanning over supports. Actual examples in which it has been suggested to work the grain in the direction of the widths of the plates in important troughing have come under the author's notice, and it will be found that the utmost vigilance is required wherever wrought iron is used to ensure that the direction of the grain is as specified, not only in regard to troughing, but also in short flange plates, in flange and bent covers of all descriptions, in connecting plates, and in almost any part of a wrought iron structure.

IRON AND STEEL IN ROOF WORK.

The employment of round rods in roof work calls for constant vigilance in the manufacture of the rods. It is quite a favourite point with smiths to weld iron and steel together in rod ends, even though the higher tensile value of steel has been calculated on in the design of the rods. The well-nigh impossible stipulation that there must be no welds in the rods is often introduced into specifications. It is comparatively easy to make the round eyes by means of staving up without welds, but not so the forked ends, which are generally employed to work with them in the same structure. Turnbuckles or coupling-boxes are generally made of wrought iron, and used as such even when connecting steel rods. Thus, if rods are used in roof trusses it is not safe to reckon on any higher tensile stress than that which can be withstood by wrought iron.

FORGING LARGE HOLDING-DOWN BOLTS AND TIE-RODS.

Undoubtedly the correct way to make the heads of bolts and the eyes of rods is by staving up the shank and stamping from the solid. As this requires a special horizontal forging press for long rods, a compromise is often adopted by lapping material round the end of the shank, and welding and forging it into shape. A flat bar collar is bent and cooled. The rod end is then heated, and the collar driven on the end. The rod is then staved up with a horizontal ram and allowed to cool—see Fig. 20 (*f*). It is again heated, then forged to a ball shape, and lastly flattened in tools under the hammer to the shape of the eye or head required.

The photograph—Fig. 20—shows five tests on rods forged by this method. The rods are mild steel and the collar best iron. Iron is used for the latter because it is softer and more easily worked. During the balling process it does not cut into the steel of the rod in the same way as steel would, but is forced down and round the staved-up end. The engraving shows very clearly what has actually happened to the iron collar. There are two faults to be noted at this stage. First, the use of iron in the manufacture of so-called mild steel rods. Second, the grain of the iron being laid across the grain of the rod. For a good weld the two grains must run in the same direction. Note also, that this is an example of iron—in a pure tension member—being used "across the grain."

Tests "*a*," "*b*," "*c*," and "*e*"—Fig. 20—all resisted a total load varying from 38 to 41 tons. Test "*d*"—Fig. 20—where the screw thread and turnbuckle was tested at the same time as the eye, broke at 41 tons at the bottom of the thread. Dividing the minimum breaking load by the smallest area—which is at the bottom of the thread—we get $\frac{38}{1.3}$ = 29¼ tons per square inch. Thus, owing to the margin of material in the rod, which is caused by the surplus necessary to compensate for the depth of the screw thread, each of these tests comes within the 28/32 standard requirement; but, if what is known as a "plus"—*i.e.*, raised—thread had been used, and the nett area of the rod had been calculated for these, the rod would not have passed the standard requirements, *i.e.*, the actual breaking stress equals $\frac{38}{1.77}$ = 21½ tons per square inch. This method of manufacture will not pass requirements without a large waste of material, whilst if only the nett area of the rod has been estimated, it cannot be allowed at all. An excess of 36 per cent. of material has been wasted in the above rods. It is interesting to notice in Fig. 20 how in an almost identical way tests "*a*," "*b*," and "*c*" have broken. Each shows a lip of lapped iron, which has come away from the rod where the iron collar has forced its way into the neck of the steel, but has never been thoroughly annealed. Test "*d*" shows that the eye is as strong, or stronger, than the area at the bottom of the thread. The most curious of all, however, is test "*e*." This shows in a very clear way how the iron collar has pared the steel shank down, and wound itself around it. But it shows more; it shows the dangerous possibilities of rods made in this way.

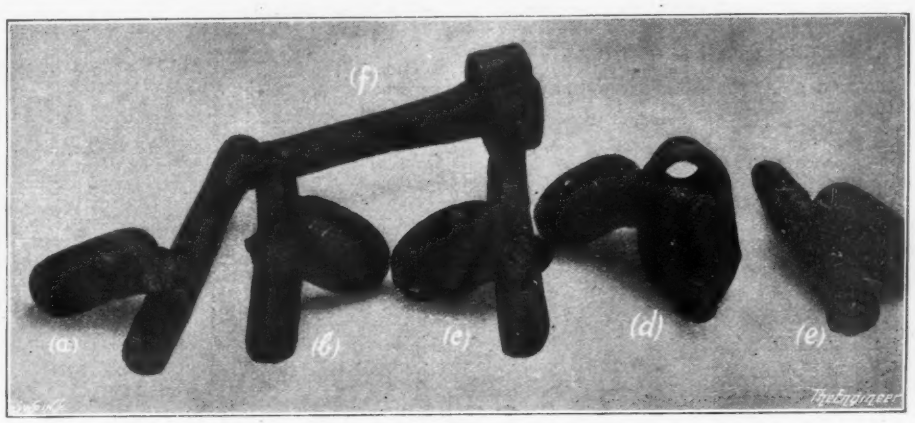


Fig. 20

Again, it is bad practice to introduce cast iron struts into roof trusses, an actual type of which is shown in Fig. 21. The absurdity of using, and endeavouring to fit turned bolts through the six or even seven thicknesses of jaws, drilled with neatly

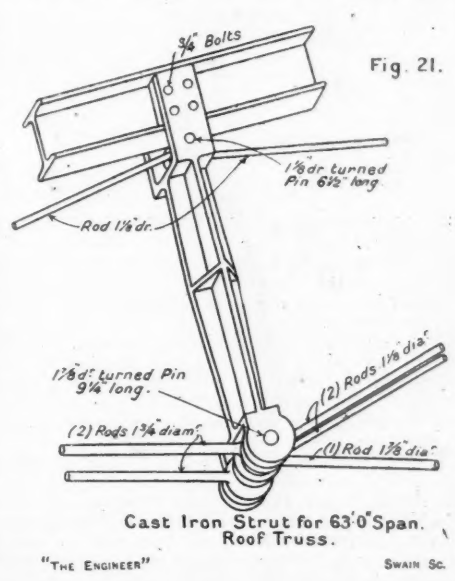


Fig. 21.

fitting holes, in such a detail as that shown, will be apparent to any engineer with workshop experience. It is impossible to drift—when cast iron is in question—or to put the slightest draw on the holes, which is very desirable in a roof truss formed with rods. It is asserted here that a good job cannot be obtained with such a design. Moreover, the practical consideration as to how awkward it would prove, should this be a shipment job, and one of the cast iron struts were broken in transit or during erection, must not be forgotten.

It is hoped that the foregoing examples will prove

that mild steel, wrought iron, and cast iron may be used with better effect than at present, but that the choice of different materials and watchfulness during the manufacture where they are used needs more careful thought than is generally exercised.

AUTOMATIC TRAIN CONTROL.

EVER since the Grantham and Ulleskelf accidents of 1906, that at Shrewsbury in 1907, and especially the Aisgill accident of 1913, the question of automatically applying the continuous brakes on railway trains, in the event of a driver ignoring an adverse signal indication, has received considerable attention from the Board of Trade, and from railway companies also. That there is need for the subject to be investigated is shown by the fact that since the Aisgill accident sixty Board of Trade accident reports have been issued, and in twenty-one of them it is stated that the accident was caused by the driver overrunning his signals.

In each of these cases it was, of course, a "stop" signal that was overrun, but as most "stop" signals have a distant signal to repeat their indication it will be of interest to know in how many of the twenty-one cases distant signals were fitted, and in how many instances the driver, after being warned by the distant signal, overran the stop signal. The reason why this information is desirable is that there is a difference of opinion as to whether the automatic application of the brake should be made at the distant signal or at the "stop" signal. We find that in seven of these cases it may be considered that the application should have been made at the stop signal. In four, *e.g.*, at Reading and Cannon-street, in 1914, the drivers started from dead in a terminal station where they could have no distant signal; in three they each admitted that the distant signal was "on," and therefore no auxiliary warning would have served any further purpose.

As showing the interest taken by the Board of Trade in this question, it should be noted that since the Aisgill report the provision of some automatic control for trains has been urged on eight occasions—two in 1914, two in 1915, and four in 1916. Until the reports on the Wigan and Kirtlebridge accidents—included in the four during 1916—appeared, no definite pronouncement had been made by the Board of Trade as to whether an automatic application at the distant, or one at the "stop" signal, was favoured. When the two reports in question appeared there was a decided expression of opinion that the apparatus should be at the "stop" signal. This is not, however, the view we take. We consider that the needs of the case would be met by giving a driver a warning at the distant signal, should he pass it in the "on" position. Then, should he ignore the warning, the brake should be automatically applied. True, this plan would have been of no use in seven of the twenty-one accidents already referred to; but in fourteen of them all the evidence favours the conclusion that, had the brake been automatically applied at the distant signal, the subsequent collision would have been avoided. Anyway, it does seem reasonable to suggest that the scheme for an application at the distant signal should be thoroughly tested first, and then, should that prove to be insufficient, the apparatus could be suitably modified to give an absolute stop at the "stop" signal.

That there are some advantages in favour of an absolute stop at a "stop" signal is admitted; it is shown, for instance, that in seven of the twenty-one cases a warning at the distant could either not have been given, or was unnecessary; in the latter case because the driver was quite aware of the fact that the distant signal was "on." Two of the former class were the Reading and Cannon-street collisions, where, as has already been said, the train started from dead in a terminal station. An automatic stop in such an instance would have been very useful, and have had none of the objections that we see in such control at signals outside terminal stations where trains may be running at speed. The automatic application of the brakes at a distant signal may be a gradual one, because, as a rule, there is half a mile or so in which to pull up. But if such action is not to be brought into use until the "stop" signal is reached the application must be full; it will therefore be sudden, and possibly unpleasant.

We think further that from those eight Board of Trade reports in which the automatic control of trains is recommended, we can see that the full application at the "stop" signal would often be too late. The first of these cases was Cannon-street in June, 1914. There the man started from dead in a terminal, and therefore it is not a suitable illustration. The second case was London Bridge in September, 1914, in which instance the driver, travelling at 8 miles per hour, had only 85 yards to pull up in. In the Smithy Bridge collision of March, 1915, the train was travelling at from 40 to 45 miles per hour down a gradient of 1 in 336, and caught up the preceding train 875 yards within the home signal. At Chaloner's Whin, on the same day, there was a clearance of 287 yards and a speed of 25 miles per hour. At Warminster, in September, 1916, at a speed of quite 40 miles per hour, the standing train was only 187 yards within the home signal. At Wigan, in December last, the 11.15 p.m. from Euston, travelling at 45 miles per hour, had a distance of 827 yards to run after passing No. 2 box home signal before reaching the 10 p.m. train. In each of these five cases the distances in which the train would have had to travel after the brake had been automatically applied would not, we consider, have been sufficient. Moreover, the desired end could have been efficiently achieved by a moderate application at the distant signal. Only at Oakley in November last, and Kirtlebridge in December, was there ample margin inside the home signal; but there, too, an automatic application at the distant would have been sufficient. We hope, therefore, that we have successfully proved that the automatic stop should be first well tested as equipped at the distant signal before being connected, as was recommended by Colonel Druitt in his Wigan report, and Colonel Pringle in that on Kirtlebridge, to the "stop" signal.

A factor of moment in this matter of distant or "stop" signal is that the distant is a very important signal, as to a driver it is the key to the state of the "stop" signals at the box he is approaching. Automatic train control tells him when the distant is at "clear" as well as when "on," and this is a valuable asset in stormy, dark or foggy weather.

Connected with this part of the subject may be noted one of the essential features of an automatic train control system. This is, that in association with the distant signal, there must be some sort of release. Many distant signals are always in the "on" position, whilst approaching terminal stations and the crossing places on single lines they are frequently so arranged. For the brake to be automatically applied to goods trains, especially when ascending an incline, is to cause delay to the train. What we consider is wanted is that when a driver passes an adverse distant signal he shall have a warning that he has done so, and if he does not then shut off steam and apply his continuous brake it shall be applied for him. After this has been done the man should be in a position to release the brake himself.

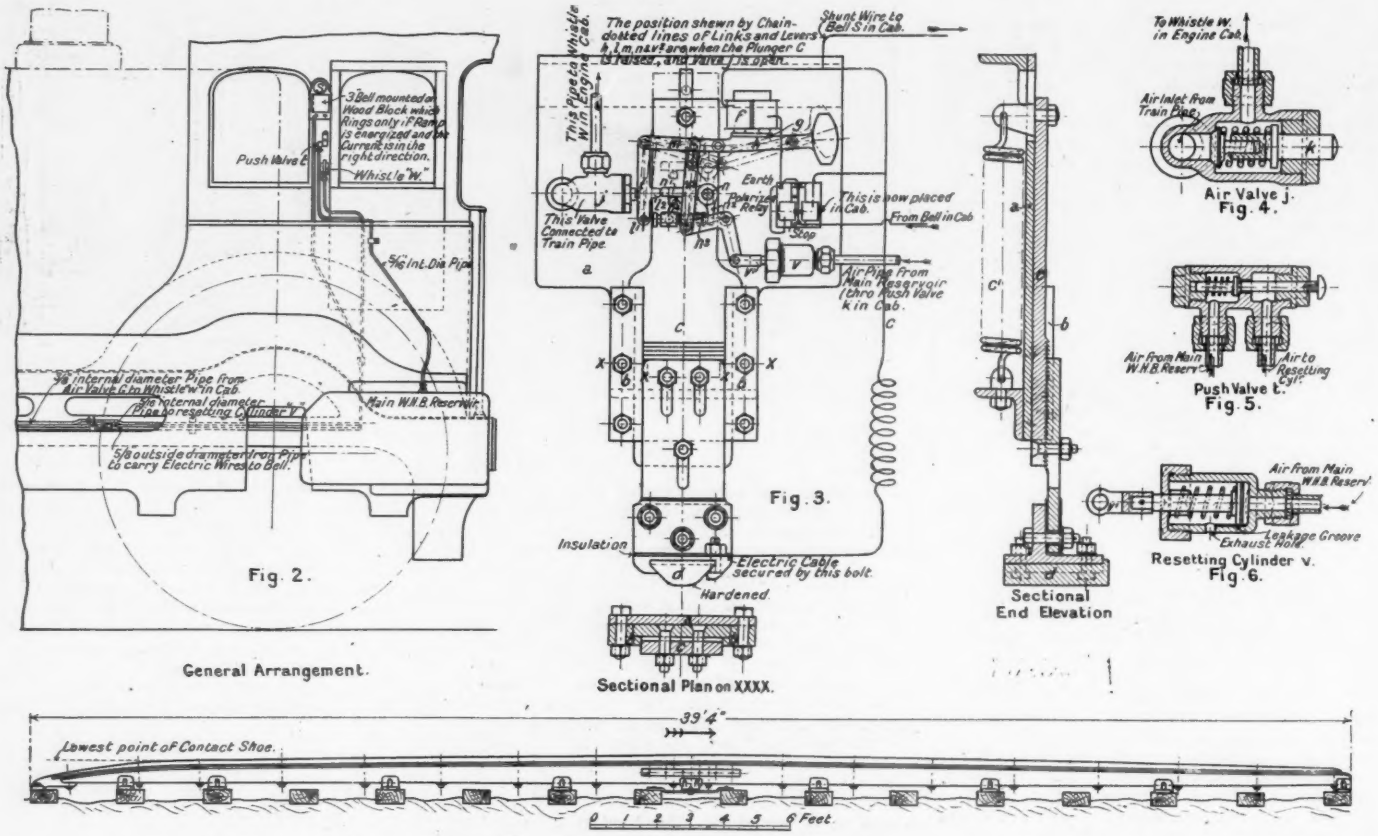

Push Valve L
3 Bell mounted on Hood Block which Rings only if Ramp is energized and the Current is in the right direction.
Whistle "W."
¾in. Int. Dia Pipe
¾in. internal diameter Pipe from Air Valve G to Whistle W in Cab.
¾in. internal diameter Pipe to resetting Cylinder V
Main W.H.B. Reservoir
¾in. outside diameter Iron Pipe to carry Electric Wires to Bell.
General Arrangement.
The position shewn by Chain-dotted lines of Links and Levers h, l, m, n, x, r, r, when the Plunger C is raised, and Valve is open.
This Pipe to Whistle W in Engine Cab.
Shunt Wire to Bell S in Cab.
This is now placed in Cab.
From Bell in Cab
This Valve Connected to Train Pipe.
Earth
Polarized Relay
Stop
Air Pipe from Main Reservoir (thro Push Valve k in Cab.
Insulation
Electric Cable secured by this bolt.
Hardened
Sectional Plan on XXXX.
Sectional End Elevation
To Whistle W in Engine Cab.
Air Inlet from Train Pipe.
Air Valve j.
Fig. 4.
Air from Main W.H.B. Reserv.
Air to Resetting Cyl.
Push Valve L.
Fig. 5.
Air from Main W.H.B. Reserv.
Leakage Groove
Exhaust Hole
Resetting Cylinder V.
Fig. 6.
39'4"
Lowest point of Contact Shoe.
0 1 2 3 4 5 6 Feet

Fig. 1. Insulated Ramp fixed at Signal.

"THE ENGINEER" SWAIN Sc.

G. E. R. SYSTEM OF AUTOMATIC TRAIN CONTROL FOR WESTINGHOUSE BRAKE

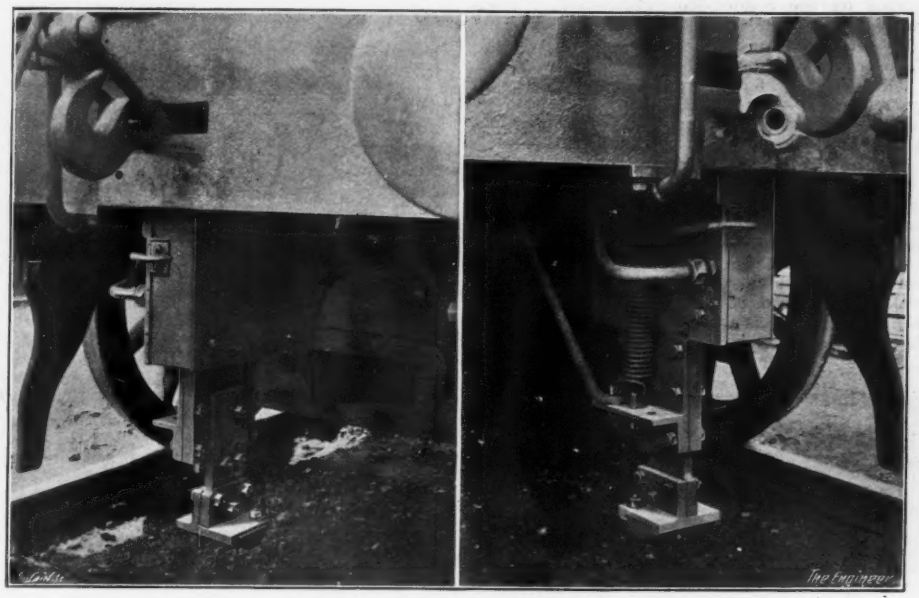
As yet, excluding the electrically-operated lines in the Metropolis, only the Great Western and North-Eastern companies have seriously tackled this subject. The Audible system of the former, and the Raven system of the latter, were both described in THE ENGINEER of December 25th, 1914. To these may now be added the Great Eastern Company, whose officers have designed a train control system which is in actual work between Stratford and Ongar, and which we are now in a position to describe.

Fixed in the "four-foot," about 40 yards before reaching the distant signal, is the insulated ramp illustrated by Fig. 1, which consists of an inverted T-iron, 4in. by 2in. by ¼in., laid on timber 7in. by 4in., and secured thereto by eighteen through bolts. The timber is carried on nine cast iron shoes, laid, except as regards the on-going end and the middle, on alternate sleepers. The ramp, both in its metal and wooden portions, is in two parts, giving a total length of 39ft. 4in., but it may be longer if thought desirable. It has a fairly sharp rise at the beginning, and then a gradual one to the middle, where there comes a gradual fall, and then a sharp one up to the end. The shoe on the engine, described later, does not come in contact with the ramp except where the rise is gradual. The ramp is protected against damage from wagon couplings and water scoops, and is strengthened by a metal nose at the on-going end. On single lines this protection is provided at both ends. The metal face of the ramp is not laid parallel with the running

rails, but on a slight diagonal ; the ends being 1½in. out of the centre line which is equivalent to a stagger of 3in. in the total length. The purpose of this is to give a better running contact to the shoe about to be described, and furthermore to ensure that the wear of the shoe shall be uniform.

The next point to be noticed is that the ramp is electrically connected to a local battery, either by a switch on the signal it repeats, or by one on the lever of that signal in the signal-box. By this the ramp becomes energised when the signal is at "clear," but is dead when the signal is "on."

Fig. 2 illustrates the essential features of the general arrangement on the locomotive where the Westinghouse brake is used—the necessary modification for the vacuum brake is shown in a subsequent illustration. For the better understanding of the engine equipment we give in Fig. 3 reproductions of larger scale drawings of the main parts.



Figs. 7 and 8—CONTACT SHOE ON ENGINE

Attached to the locomotive in the most convenient position is a plate *a*, Fig. 3—see also Figs. 7 and 8—suspended from which are the guides *b b*. Within the guides is a plunger *c* having at its lower extremity an insulated shoe *d* so situate as to be in alignment with the ramp already referred to, but, normally, below the level of the highest point of the ramp. The plunger *c* is, as will be seen from the sectional end elevation of Fig. 3, in two parts so as to allow for adjustment. To it is attached a spiral spring c^1, the lower end of which is attached to the plate *a*. When the plunger is raised the spring is put under tension, and this ensures that the plunger will again fall to its normal position.

The shoe *d* is electrically connected by wire *c* to the electro-magnet *f* which has an armature *g* on the weighted lever *h* attached to the plate *a*. On the other side of the plunger, and also attached to the plate *a*, is a valve *j*—Fig. 4—connected to the train brake pipe, which is kept closed by a spindle *k* acted upon by the lever *l*, which is hinged on the bolt l^1 attached to the plate *a*. The lever *l* is attached to lever *h* by the link *m*, the whole forming a toggle or linkage system controlled by the magnet *f*. Attached to the plunger *c* is a trigger *n*, the arm n^1 of which normally abuts against the projection l^2 on the lever *l*, whilst the arm n^2 is connected to the spring n^3, which keeps the arm n^1 resting on the stop n^4.

It will already have been appreciated that when an engine passes over a ramp the plunger *c* is raised, and that, should the ramp be energised, the current from the local battery will flow through the ramp and shoe *d* to the electro-magnet *f*, so that the latter would be energised. The lever *h*, through the armature *g*, would thus be attracted, and through the link *m*, would thus firmly hold the lever *l* against the spindle *k* of the valve *j*. If, however, the signal is "on" the ramp will not be energised nor, therefore, when the shoe *d* passes over, will the magnet *f* be energised. The plunger *c* will, nevertheless, be raised, and the consequence of the magnet *f* not being energised would be, that as the trigger *n* attached to the plunger was raised, the arm n^1 would release the lever *l* so that the linkage arrangement would collapse, as shown in dotted lines in Fig. 2. The lever *l*, swinging free, would cease to hold the spindle *k*, and thus the valve *j* would be opened, air would escape from the train pipe, and the brake would be automatically applied. The whistle *w*—Fig. 2—would also be blown, and give an audible danger signal. If, however, the ramp were energised, and consequently the magnet *f*, the linkage arrangement would be held rigid. Not only then would the valve *j* be kept closed, but a circuit would be made to the bell *s* in the engine cab, causing it to ring and give an audible "clear" signal.

When the plunger *c* is raised the trigger *n* and its arms are in the position shown in dotted lines in Fig. 3, and should the linkage arrangement be in the collapsed state, the arm n^1 would, when the plunger fell, come to rest on the projection l^2 of the lever *l*, once more ready to hold the lever and, therefore, the spindle *k* in position. These parts are restored to their positions when the driver presses in the button *t*, Fig. 2, in the cab—see also Fig. 5. Air is opened from the main reservoir to a small cylinder *v*, Fig. 3—see also Fig. 6—so that the piston v^1 is forced outwards, the link v^2 raised, and the linkage arrangement reset. When the lever *l* resumes its normal vertical position, the arm n^2 will fall on to the stop n^4 against the projection l^2, and cause lever *l* to push in the spindle *k* and close the valve *j*, so that the brake is released and the whistle *w* stopped.

As yet we have only described the arrangement for the Westinghouse brake, but in Fig. 9 we show the modification for the vacuum brake. Here, the control valve *x* is kept closed by the lever *y*, corresponding to lever *l* in the other illustrations. When the lever *y* is uncontrolled, as is the case when the magnet *f* is not energised, the control valve *x* is opened, the vacuum brake applied, and the syren in the cab sounded. The resetting cylinder *z* is actuated by the push button *t*, as in the Westinghouse arrangement, except that the resetting is done by an auxiliary vacuum reservoir. Other suitable modifications are made for engines equipped only with the steam brake, or with combinations of steam and vacuum brakes.

All the parts, except the shoe and those in the cab, are boxed in, as will be seen from the photographic reproductions. Only one other point needs to be mentioned. This relates to the arrangement necessary where, on single lines, trains travel over ramps in either direction ; an up train, for instance, then passes over the ramp for a down distant signal. The signal, in such a case, is not, of course, at "clear." It would not, however, do for the brake to be applied, so, in such a case, the ramp is energised by other means, and energised negatively. As a result, when the plunger rises, the magnet *f* picks up the current and the brake is not applied, but the negative current, acting on a polarised relay, short-circuits the bell so that it does not ring. The energisation negatively of the ramp for an opposing movement is done through the withdrawal of the electric train staff or tablet, or should the train staff and ticket system be in use, then through contacts on the block instruments.

Three important features may be briefly noted. The first is that the automatic application of the brake is a purely mechanical movement ; no electricity is employed for giving a danger signal. Electricity is used only when a "clear" signal has to be indicated. The second is that, as is self-evident, the failure of any part will cause the brakes to be applied. The third—and this is a point that is of great value—is that engines equipped with this apparatus will receive the same signals, and be equally controlled when running over similar ramps on other lines, provided they are fixed in the same relative position. In exactly the same way, the engines of those other companies running over the ramps fitted with the Great Eastern system would be controlled just as on their own lines.

The sole licensees for the apparatus now described are the W. R. Sykes Signal Interlocking Company, 26, Voltaire-road, Clapham, S.W. 4

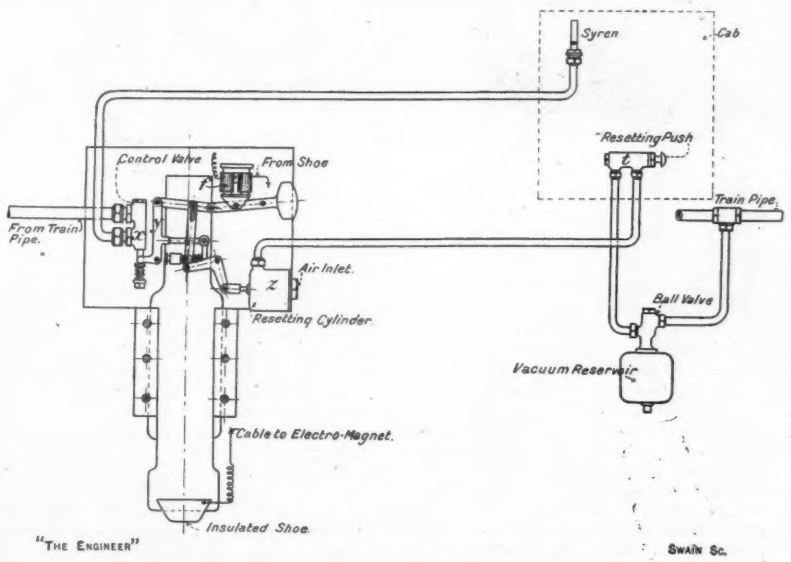


Fig. 9—G. E. R. AUTOMATIC TRAIN CONTROL FOR VACUUM BRAKE

ADMIRALTY APPEAL TO WORKERS.

THE Iron and Steel Trades Confederation has received the following message from Sir E. Carson, First Lord of the Admiralty, and Sir J. Jellicoe, the First Sea Lord :—

"The Board of Admiralty wish to impress on all engaged in building or repairing ships how serious are the times in which we live. A determined enemy has set himself to blockade our islands and to destroy the merchant ships which bring food to the people and supplies to the Army, and is using methods which are contrary to the law of nations. Every day merchant ships are being sunk, and we need to use all our resources to prevent our being threatened with starvation. The enemy knows this, and has staked everything upon it. If he succeeds, victory will rest with him ; but, if he fails, his defeat is certain.

"There are only two weapons that we can use, and both can only be forged in the shipyards of the country. One is the class of warship that enables the Navy to hunt and destroy the enemy's submarines ; the other is every new merchant ship that takes the place of a ship that has been sunk. These weapons must both be used together, and upon the men of the shipyards and engineering shops depends entirely the output of these weapons. How this output can be increased is a question that concerns every one of us, and no measure that helps to make better use of our labour and our machinery can be neglected. We, who are secure in our homes, owe it to the brave men who are dying hourly for us on sea, on land, and in the air, to spare no effort to give them the weapons with which to win the war for us.

"The Board of Admiralty are confident that, in the supreme crisis of our history, the men in the shipyards and the workshops will see to it that this appeal shall not fall on deaf ears."

THE Minister of Railways and Harbours of South Africa budgeted, a year ago, for a deficiency of over £40,000, but the results have been an increase in receipts of over one million pounds, which higher expenses reduced to a net increase of nearly £800,000. This better result is mainly due to an increased coal revenue of £700,000. Train mileage was increased by 14 per cent.

SUSPENSION BRIDGES IN NEW ZEALAND.

SUSPENSION bridges, designed and built by Mr. Joseph Dawson, of Pahiatua, New Zealand, have been erected in various parts of the Dominion, and have attracted a considerable amount of attention from Government, local body, and private engineers. They have stood very severe practical tests, and many experts have expressed themselves eminently satisfied with their stability, simplicity, and comparative cheapness. Mr. Dawson claims to construct his bridges very much more cheaply than those erected by the Government. He personally supervises their construction, and carries out their erection by day labour. He has, so far, built fifteen, the earliest having been erected twenty years ago. It was for a settler at Kopuranga; it had a span of 90ft., and cost less than £100.

Mr. Dawson's latest structure, of steel and reinforced concrete, is over the Hutt River—at Maori Bank—Wellington, was erected for Messrs. Whiteman Bros. and Cottle, property owners in the locality. It has a span of 170ft. and a width of 12ft., and the cost of the structure worked out at £8 per foot run.

Some time ago plans were submitted by the Government and Mr. Dawson respectively of a bridge at Rangitikei of a length of 253ft., with a height of 278ft. The Council had great difficulty with the Department respecting the matter, but it staked its reputation on Mr. Dawson's structure, and the bridge was built at from £1000 to £1200 less than the estimated cost of a bridge of the Government's design.

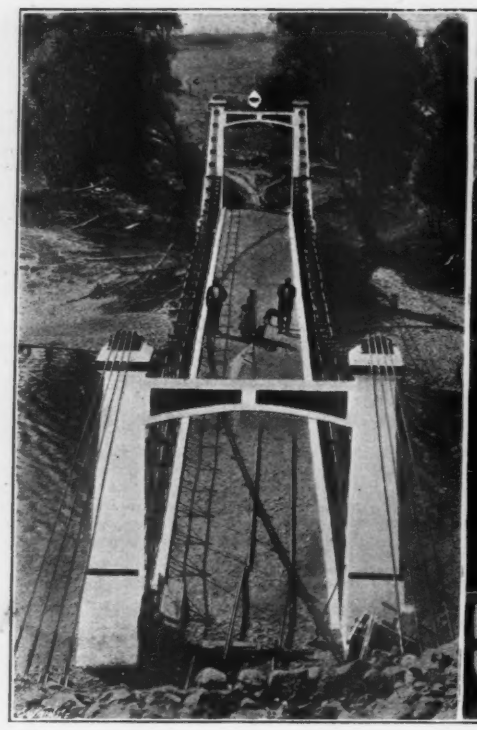


Fig. 1—UPPER HUTT BRIDGE

Fig. 2—TAOROA BRIDGE

We give, in what follows, particulars of several of the Dawson bridges:—

THE UPPER HUTT BRIDGE OVER THE MAORI RIVER.

There are two 25ft. towers on each side of the river. They stand on concrete beds and are themselves of reinforced concrete, each pair being connected by an arch of concrete. On the top of each tower are castings, with twelve iron wheels, for the cables to pass over. The anchor rods—sixteen in number—are of 2in. iron upset 2¼in., connected to the anchors with large iron washers. The eight cables have each a breaking strength of 75 tons, the eight totalling 600 tons, while the suspending rods—sixty-two—are of ⅞ iron attached to the cables by clips at every 5ft. The cross girders are spaced at 5ft. centres, and have curved corrugated iron between them to support a reinforced concrete deck. Throughout the structure is concrete, steel and iron, no wood whatever being used. The total weight of the bridge on the cables, including the concrete deck, is 60 tons, of which 15 tons is iron or steel. The weight, it is said, is 15 tons heavier than would have been the weight of a wooden bridge. The anchors, it may be mentioned, are enclosed in solid concrete to a depth of 35ft. The height of the bridge above normal level of water is 25ft.

The bridge is illustrated in Fig. 1 on this page, and in Figs. 3 and 4 on page 56. The old Maori canoe seen in the two latter views was utilised to convey down the river the gravel used for the concrete in the bridge, carrying half a yard at a time!

TAOROA—TAIHAPE—BRIDGE.

This bridge, a view along which is given in Fig. 2, has a clear span between towers of 253ft., the deck being 270ft. above the Rangitikei River bed, near Taihape, North Island.

There are two ferro-concrete towers on each side of the river, and from them eight steel cables support the bridge. The cables have a breaking strength of 672 tons, and the bridge structure weighs 60 tons. There are 124 suspending rods ⅝in. in diameter. The stiffening truss is built of wood and iron. The cost, with that of the approaches, which were somewhat heavy, was £2200.

UPTON DOWNS' BRIDGES, MARLBOROUGH, SOUTH ISLAND.

Two of the Dawson suspension bridges, which span deep gorges some 180ft. above the stream bed, are situated on the Seddon-Molesworth-road, Awatere County (Marlborough), and are about twelve miles from the township of Seddon.

The bridges are of similar design, and have a span of 96ft.—see Figs. 5 and 6, page 56—and 80ft.—see Fig. 7, page 56—respectively. The anchor towers are of concrete. The anchor rods pass through iron pipes embedded in the concrete anchor blocks, and are fixed at the back of the concrete with washers and double nuts. The rods are 2in. in diameter and upset 2½in. at the threads. They are fixed to the cables which have a solid thimble spliced in each end, with iron straps and bolts. The clips on each side of the thimbles have 1⅛in. bolts passing through them. There are four cables, which have each a breaking strength of 85 tons, or collectively 340 tons. Each anchor bolt has a breaking strength of 66 tons. The cables are 5in. in diameter and pass over the towers on a cast iron saddle with six iron wheels to each cable. The suspending rods that carry the bridge from the cables are composed of steel 1in. in diameter, and are spaced at intervals of 5ft. and fixed to the cables with clips. They each have a breaking strength of 14 tons. The steel channel that holds the concrete decking is double, with a space left between to receive the suspending rods. From the flange of the channel curved corrugated iron is put at 5ft. centres to receive the concrete deck, forming a series of arches throughout the bridge, which has a camber of from 1in. to 8in. A top dressing of 4in. of concrete is put on, to make a solid deck. The longitudinal trusses are double—that is, there are two trusses on either side of the bridge. They are spaced 1ft. apart, so that the cables can go between them. They are 5ft. high and have a 5 by 4 timber top and bottom, with galvanised iron pikes between, spaced to 5ft. centres.

These bridges cost, with commission added, £7 12s. 9d. per foot run.

During the tests a 13-ton traction engine was driven on to the structures, and only the very slightest oscillation was visible while the engine was moving. It was stopped in the centre of the bridges and tests of the deflection were taken. With over 150 people on the longer structure, besides the engine, the deflection registered was under 1¼in. The deflection on the shorter bridge was under 1in.

ASHLEY-CLINTON BRIDGES.

Two bridges have been built by Mr. Dawson for the Waipawa County Council (Hawke's Bay) at Ashley-Clinton, one being 165ft. span—see Fig. 8, page 56—and the other 155ft. span—see Figs. 9 and 10, page 56.

The anchor blocks and towers of each bridge are composed of reinforced concrete. The anchor rods pass through a 3in. pipe let into the concrete, and are secured at the back of the anchors with washers and double nuts. The cables are eight in number, with a breaking strength of 85 tons each, the eight totalling 680 tons. They rest on wheels on top of saddles, as in the case of the other bridges. The suspending rods that carry the bridge from the cables are of 1in. diameter. The cross girders are of double channel iron, and they are spaced at 5ft. centres. Between them are arches of reinforced concrete, resting on 22 gauge corrugated iron, on the top of which there was arranged woven steel for reinforcing the concrete floor of the deck, which is 4in. thick over the top of the arches. The camber of the bridge between the towers is 1ft. 6in.

Each bridge has double trusses on each side, 5ft. high, composed of ¾ bolts and vertical pipes, with top and bottom stringers of Totara. The cables go between the trusses on both sides. The suspending rods are so fixed to the cables with clip bolts that they cannot get out of place. Each bridge is practically all concrete, steel and iron, and the total weight of the structure on the cables is about 52 tons.

A SYSTEM FOR FUSE INSPECTION.

A GREAT deal of attention is being paid just now to works organisation, and it must at once be realised, as was set forth in a recent paper by Messrs. A. W. Reeves and Cecil Kimber, read before the Institution of Automobile Engineers on this subject, that no one system can be applicable to all works. For one reason, the layout of the works varies in almost every case, but furthermore the object to be attained by a system differs according to the nature of the work to be executed. One business, for instance, may be engaged in general engineering, where orders not only have to be obtained, but vary in complexity of execution, design, and number of pieces to be manufactured, and a lot of different orders have to go through the works at the same time; another may be on lines, common nowadays, and consist simply in the execution of a running order for a single article turned out in quantities limited only by the capacity of the plant. The system to be employed in the former must, in the nature of things, be somewhat complex, and is liable to fall to the ground by its very complexity, which may call for a vast expenditure on forms and cards to enable it to work at all. A system which will deal satisfactorily with the second type may be wonderfully simple, and the number of forms and cards may be reduced to very small proportions, and it is such a system that we propose to describe in connection with the fuse department of a certain factory.

THE OLD SYSTEM.

This will give us a very good opportunity of illustrating how a system, excellent in itself, may fail simply from the number of accessories necessary to enable it to work properly, and in order to do this we shall have to begin with a few notes on the system which was in operation when a different and smaller type of fuse was being manufactured. In this system the fundamental idea was that a batch of 50 fuses should be passed through the works in boxes coloured to indicate the last viewing operation they had undergone; thus, after the bodies came off the automatics, machined from the bar, they were placed in plain wooden boxes and handed to the viewers, whose benches were close against the machines. They were taken from the boxes, viewed, and those which passed inspection were placed in a green and white striped box, the colour of the box being the only indication necessary that they had been viewed, it being understood that only the viewers had a right to take parts out of a box of one colour and put them in a box of any different colour. This green and white box was then passed on to the next operation, or series of operations, the operator filling up an empty box of the same colour alongside his machine with the fuses as he completed the operation. This box was then passed to the viewers for that particular operation, the fuses were viewed and transferred to a green box, and so on through different coloured boxes until the whole of the machining operations were completed. This system only necessitated the use of a simple card in each box, the card being of the same colour as the box, to show the number of fuses rejected and the operator's number, which served as an indication of the work to be credited to each operator. With a large output of several thousand fuses per week a large number of boxes was necessitated, but the plan was found to work well, as it caused little loss of time in filling in cards, and afforded easily visible evidence to the managers and foremen that the work was going through in the correct sequence, and especially it drew attention to the presence in any part of the shop of rejects, which were always placed in a black box, and to rectifications, which were put in a black and white striped box.

After the system had been at work for some time the firm was changed over to another make of fuse, larger in size and heavier in weight, so that the number that could be comfortably handled by girl labour in a single box was reduced from 50 to 10 pieces. This meant multiplying the boxes of

each of the six different colours and the cards by five, so that the cost of the system alone would have been considerably increased, and the colour scheme was dropped in favour of a metal tray for the bodies in whatever stage they might be, each tray holding ten bodies; this simplification was rendered the more possible from the fact that the trays and the system were introduced when manufacture commenced, whereas manufacture of the smaller fuses had been under weigh for some time before the production was really systematised, so that there was a lot of material in the shops which had not gone through any recognised sequence, and the boxes were of great value in discriminating between the bodies which were part of the regular system and those which were not. It may be worth reminding our readers that, in introducing a system at an advanced stage of manufacture, it is necessary to begin at the first operation, so that a pure stream, as it may be called, may be started at the earliest possible moment rather than begin systematisation, say, on the assembly benches, when it is almost impossible to work it backwards against the continually growing stream of unsystematised material.

The alteration deposed the tray or box from its position as a fundamental part of the system to that of a mere accessory, and the old plan has only been dealt with at such length in order to show how easily a system may be rendered practically unworkable.

THE NEW SYSTEM.

The machining proposition involved in turning over from a fuse of which the body is turned out of a bar in an automatic machine to one in which the body is a stamping is of considerable interest, but we are only able to deal here with the general system introduced, and not with the machining side of the question, and we will therefore confine ourselves to a description of the means adopted for keeping up the flow of correct pieces through the works, commenting as we go along.

The first operation is to machine down the stamping to enable it to be chucked, and the stampings, as they are delivered into the works, are simply dumped into a large bin alongside the lathes where they are turned down, and, after gauging, sent to what is known as the Main Machining Depôt, which is a very important feature of the system, and may be called the heart from which the stream of pieces is made to flow through the arteries until they return as completely machined bodies.

The Main Machining Depôt sends these bodies prepared for machining to large lock-up bins alongside the next set of machines in duly recorded quantities, and from these bins the operator draws and submits the bodies to the first series of main machining operations. The viewer is stationed immediately against the machine, and views the bodies as they come off, so that any wear of tools or other trouble is immediately noticed, and the production of scrap stopped. The parts that pass inspection are then, for the first time, placed in the metal trays, ten to a tray, and returned to the depôt, while those parts which are found faulty in any dimensions are put into wooden boxes, and also returned to the depôt, so that the depôt is able to keep a complete record of the good and bad work, and loss of material is guarded against. We are much interested to note that, instead of writing out a "fault" ticket showing the nature of the defect, and placing the ticket in the fuse where it is always liable to get misplaced or lost, and which anyhow takes time to write out and time to open out and read, a series of symbols has been prepared, each symbol indicating the exact dimension which is not to gauge, and these symbols are stamped upon the fuse as far as possible in a place where it will be removed when rectification has been carried out. It is not, of course, always possible to remove the symbol so that it may not go through with the finished fuse; this is, however, of no importance, and the plan effects a great saving of time, while ensuring that a piece cannot be wrongly labelled, as is liable to happen through the interchange of tickets, nor can a part arrive in the depôt without any indication at all of the trouble owing to the loss or illegibility of the ticket. The method of dealing with the rejected parts will be dealt with later.

Each tray of ten is then provided with a ticket—see Fig. 1—clipped to it so that it cannot get adrift,

FIG. 1.—*Sequence of Main M/C Operations* 2.

BODY.

Tray No..... Date of issue.....

	Operat or's No.
(2) Turn. Champfer. Undercut. Rough bore magazine. Finish bore magazine. Turn and face reduced part and finish bore for det. plug	
(3) Wash	
(4) View and depôt	

indicating the next series of operations through which the parts must pass. The only writing on the card is the tray number and the date of issue, which is done in the depôt, and the operator's number which is done when it arrives at the machine.

It will thus be seen that very little clerical work is required either in the depôt or on the part of the operator, apart from the records which have to be kept in the depôt of the trays passing through the various operations.

It will be realised that, for the working of this system, the operations necessary have first to be determined and arranged in their proper sequence, and then divided up into a convenient number of circuits to entail the least possible number of visits to the depôt, while ensuring that the trays do not hang up between the various operations. Up to now each circuit has entailed a visit to only one machine before returning to the depôt, and the cards, all of which are conspicuously marked with the number of the circuit, and which have hitherto been of the same colour—white—are now pink, as no less than six different operations are carried out on a single circuit; they are, however, all drilling operations, and the drills are situated alongside each other, so that it is simply a matter of passing the parts from machine to machine without putting them into their trays until the last operation is performed, and after they have been viewed for all six holes. It may be well to point out here that in all these operations it is only the correct parts that are put into the metal trays, the rejects still being put into wooden boxes, so that it is necessary to have a pile of wooden boxes alongside the viewers while the metal trays accumulate in the course of a day. Special labour is, however, detailed to remove the excess trays, and to supply wooden boxes throughout the day. Otherwise the metal trays are only sent from, and returned to, the Main Machining Depôt with a full complement of ten pieces, and this same system goes on through a few more operations till the body is complete as far as machining is concerned.

VIEWING AND CORRECTING.

All viewing up to the present has been carried out by the firm's own viewers, but the parts now have to be submitted to a more severe ordeal—inspection by the "Woolwich Examiners," who have a shop set apart for their use in the factory itself. At this stage the bodies are transferred from the metal trays to wooden "assembly" trays, also holding ten each, and these trays are sent in to the inspectors, who return the fuses which are found correct to the Main Machining Depôt, which in turn passes them on to the Assembly Depôt. The parts rejected by the Woolwich inspectors are retained by them, and a list is furnished to the firm from time to time, so that when a sufficient quantity has accumulated they can be released for rectification; this is a matter solely between the rectification department and the examiners, and only the accepted parts are returned to the Main Machining Depôt.

It will perhaps be well here to go into the method of dealing with rejections, which is a matter of the utmost importance. As has already been noted, all rejects in the course of machining operations are put into wooden boxes and returned to the depôt, each piece stamped with a symbol indicating the nature of the defect. As these accumulate in the depôt they are sent to the Sorting Depôt, where the defects are classified, and all parts defective in one dimension are placed together and sent out for rectification in boxes with a "special operation" card of a conspicuous colour to differentiate them from the pure stream going through the shops. In a well-balanced shop, however, there should be no room for the interpolation of such a subsidiary stream, so that this work has to be done by running overtime or even on Sundays, if it is excessive. The execution of the "special operation" rectifies the piece, and it can then be returned to the depôt, and take its place in the pure stream, whilst those parts which cannot be rectified are scrapped in the Sorting Department, and a return made to the depôt so that a check can be kept on the amount of material passed through.

There are a number of detail parts which pass through the works on the same general lines till they finally reach the Assembly Stores, from which they are issued as required, to build up the fuses into the complete article, but as they involve no new principle they need not be dealt with here.

This system is not put forward as the only or the best system of quantity production, but it is a simple one, and above all it is not weighed down with a multiplication of forms and cards which are sometimes on a scale which requires a staff, bearing a very large proportion to the actual operating staff, to operate them. The nature of the work is, in this case, such as to permit of this very simple form; but we shall hope later on to have an opportunity of describing other manufactures which call for greater complication. We are of opinion that viewing should be carried out on the parts as they come off the machines, as, unless this is done, the rapid output of the present-day automatic machine soon leads to the production of a lot of scrap which occasional viewing by the operator can never hope to keep within reasonable limits.

AT the Albert Stanley Institute, Hammersmith, recently, Sir Albert Stanley, the President of the Board of Trade, and formerly managing director of the Underground Electric Railways, and of the London General Omnibus Company, was presented with a testimonial from the administrative staff of the companies associated in the Underground group. In making the presentation special reference was made to the great interest that Sir Albert had always taken in the staff.

EXCESS PROFITS PROBLEMS.

THE inconvenience and hardships which have been inflicted on industry by the excess profits law and munitions levy was the subject of editorial comment recently, and if we now return to the subject it is because these matters are still and are likely to remain in the region of controversy. There is general dissatisfaction, not only with the high scale on which taxation has been fixed, and which can only be regarded as a sop to the labour element in the State, given regardless of the future of the industries so severely taxed, but at the difficulty of ascertaining the precise amount of indebtedness under these heads, and the impossibility in many instances of determining the financial position of enterprises subject to this taxation. It is the fact that some of the public companies affected have been unable to issue any complete accounts since the year 1914, and that many munition and engineering concerns anxious to distribute a share of profits earned among shareholders has had to make up a rough account in which guesswork and conjecture have assumed the *rôle* of auditors.

Among the many questions which have vexed the souls of directors, apart from the scale of special taxation, not the least refer to the correct method of valuation of stocks, and to the allowance it would be proper to make for wear and tear, depreciation and obsolescence of assets. In normal days these matters may cause discussion, but there are certain well-established principles to be followed, and the way is fairly clear. The circumstances under which war contracts are being carried out have played havoc with the old methods of preparing accounts. Extensions of factories have been made, and new tools and equipment provided, which, however valuable as assets, at the present time, may have only scrap value when the change over is made from war to peace conditions. The new and existing machinery and plant has, in the pursuit of high output, been subjected to wear and tear at a much higher rate than if operated under normal conditions. Stocks of a very special character arising out of the needs of the war have been accumulated. From all which it is obvious that if the old rules of valuation, of allowance for wear and tear, provision for depreciation, and the usual tests for obsolescence were imposed, great injustice might easily be inflicted on industrial concerns which have laid aside the whole of their ordinary activities to undertake war contracts.

The points at issue are important, and the regulations on the subject which are contained in a White Paper recently issued have been studied by manufacturing firms in all parts of the country with a good deal of interest. In some respects the new regulations constitute a distinct departure from the terms of existing Acts governing the matters in question. The general principle for the valuation of stocks is either cost price or market value, whichever is the lower, but having in view the probability that certain stocks may very rapidly depreciate after the end of the war, a period of one year is to be allowed after the termination of hostilities in which to ascertain by actual realisation the value of the stock appearing in the accounts, and an allowance is to be made from the profits of the last financial year for the difference in value. With regard to wear and tear, and depreciation, the new regulations, without making any notable concession, clear up some disputed points in the application of the Acts. In addition to the diminution in value due to wear and tear of plant and machinery, ordinarily allowed under the Customs and Inland Revenue Act, special allowances are to be made under the Act governing excess profits duty for postponement or suspension of renewals or repairs, exceptional depreciation due to the war, and the necessity of providing plant which will not be wanted after the war. These allowances extend to any material assets and not merely to machinery and plant, and where assets have been acquired during the war at an inflated price, and will sink to a lower level of value, or even to scrap value, at the end of the war, full relief can be claimed. If the allowances granted under these various heads are not deemed satisfactory, an appeal may be made to the Board of Referees appointed under the Munitions of War Act.

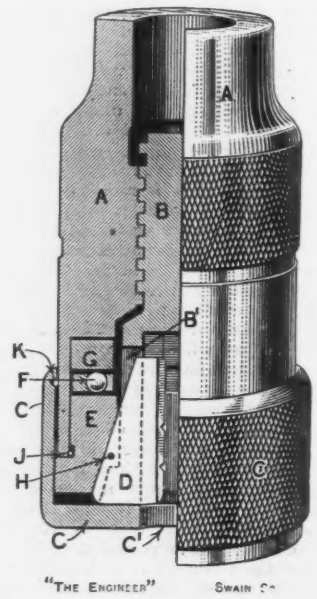
The new regulations have certainly served to clear the air. They leave untouched, however, the real question which is agitating the engineering and allied industries, and that is the handicap which excessive war taxation is imposing on concerns which will need large financial resources if they are to compete effectively in the world's markets for international trade. The special case of the shipping and shipbuilding industry, where the replacement of sunk shipping is a national need, was dealt with in a recent issue of THE ENGINEER: the lack of large capital resources such as might have been accumulated had taxation fallen with a lighter hand on industry must place our manufacturers at a disadvantage compared with enemy firms whose war earnings have not been mulcted for excess profits duty, but have been reserved as an after-the-war fighting fund.

We have given here a general outline of the position, and we discuss some aspects of the question in a leading article to-day.

THE "MARVEL" DRILL CHUCK.

We have lately had an opportunity of examining some examples of the "Marvel" drill chucks which are made by Louis Wearden and Guylee, Limited, of Snowden-street, Bradford. These appliances are well made, possess a number of interesting features, and are at present obtainable in three sizes, namely, No. 101 to take drills up to $^{9}/_{32}$in. in diameter; No. 102 to take drills up to $\frac{3}{8}$in. diameter; No. 103 to take drills up to $^{9}/_{16}$in. diameter. A fourth size, No. 100, to take drills up to $^{5}/_{16}$in. in diameter, is being prepared. The chucks are supplied for use with either Morse taper, or parallel mandrils, or with shanks made to fit holes in lathe turrets, &c. The general internal mechanism is, however, the same for all the different forms of chuck, and a description of one of them will cover the whole series.

A drawing of the $\frac{3}{8}$in. size is given in the accompanying illustration, which is practically the same size as the original, and the working will be readily understood. The chuck consists first of all of a main body A. This may either be bored at the top to receive the mandril, as shown in the engraving, or prolonged so as itself to form the shank. The lower part of the body has bored in it a wide and deep hole, a strong shoulder which takes the thrust being thus formed. The central portion is furnished with a square-headed thread, and in this thread works the spindle B, the lower part of which is formed with a cap or boss C which is perforated with a hole C^1 for the passage of the drill shank. As shown in the drawing, this spindle with its cap is screwed fully "home" and enshrouds the lower part of the body A. The diameter of the spindle B is increased just below the lower termination of the screw thread and a hole bored in its lower end, this hole being a continuation of, and of the same diameter, as the hole C^1 in the cap or boss, and hence just larger than the largest drill for which the chuck is made. At intervals of 120 deg. round the circumference of the tube



"THE ENGINEER" SWAIN Co.

THE "MARVEL" DRILL CHUCK

of metal formed by boring this hole, radial slots B^1 are cut for the accommodation of three hard steel jaws D, the outside or projecting edges of which are formed to the same taper as is the hard steel coned ring E which embraces them. It is evident then, supposing the cap C to be unscrewed, that when it is screwed up again the action of the cone on the taper edges of the jaws will be to force the latter radially inwards into the hole C^1, so that a drill shank will be gripped and held centrally by the jaws, the length of the gripping edge of which is about $1\frac{1}{4}$in. The makers point out that as the feed is increased the tightening pressure of the grip also automatically increases—the greater the pressure the more the jaws are clamped by the coned ring against the drill shank—and they claim that this does away with all possibility of the drill slipping. It may here be said that in order to cause the jaws to open out so as to allow drills to be inserted between them, when the cap is unscrewed, they are each perforated with a small hole H through which is threaded a light steel wire bent to a radius rather greater than that of a circle described through the holes when the jaws are in their widest open position. This arrangement, simple as it is, is apparently quite satisfactory.

When at work the coned ring E, of course, revolves with the spindle and the jaws. To take the thrust a ball ring F and a hardened steel washer G are provided. The only criticism which we have to offer as regards the whole design is that there is no means of oiling this ball ring without removing the chuck from the drill, and, partially, at any rate, dismantling it. This, however, is a minor point, since such a bearing would require but very little lubrication, and the process of dismantling is very simple, as we shall now show. If there were nothing to prevent it, the spindle and cap could evidently be detached from the main body by unscrewing. This, however, might result in the two portions coming apart when it was not desired, and accordingly the internal periphery of the cap is furnished with a groove K into which is sprung a light steel wire spring, and the external diameter of the lower portion of the coned ring E is made slightly larger than the external diameter of the body A. Consequently, although the cap can be readily unscrewed till the edge of the cone ring is reached by the spring, it cannot be unscrewed any further. A similar spring inserted in the groove J formed in the interior periphery of the hole in the main body prevents the coned ring, bearing, and washer from falling out when the cap is removed. It is an easy matter to remove both these springs by the aid of a small tool which is supplied by the chuck.

We may add that we are informed by the makers—and though we have not actually tested it ourselves, we can readily understand that such is the case—that by giving the cap C a brush with the hand in the direction of rotation it can be unscrewed, the drill removed, and a different drill inserted while the chuck is revolving.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE "PENALTY" OF FAILURE IN THE BRITISH ARMY.

SIR,—It is not entirely without precedent that cases have occurred in the Army Higher Commands where an officer, failing to carry out a certain operation with success, is shelved and given a soft job with possibly increased pay.

This may be an act of diplomacy on the part of the Army Council, but in Heaven's name can anyone explain the following: In one branch of the Army Ordnance Department candidates are asked to join as "Temporary Inspectors of Ordnance Machinery, 3rd class," carrying the honorary rank of Lieutenant (I.O.M.). The necessary qualifications for this branch of the Service are:—(1) A first-class education, with a knowledge of higher mathematics; (2) being a member of one of the recognised Institutions of Engineers; (3) at least ten years' experience in engineering practice; (4) experience of workshop practice, and the handling of skilled and unskilled labour, &c. After these points have been assessed the prospective I.O.M., if considered sufficiently qualified, has to undergo a course at the Ordnance College, lasting over a period of four months, covering a series of subjects dealing with the guns of all description used in the Services.

At the end of the lectures on each subject, each of about a fortnight's duration, he is examined, and has to obtain a certain percentage of marks before passing out. If, however, through incompetency, he should fail to satisfy the examiners as to his fitness to take up his appointment, he is transferred to the Stores branch of the Army Ordnance Department. The daily rate of pay for an I.O.M. is 13s., whereas that of a temporary Lieutenant in the Stores branch of the same department is 8s. 6d., plus an extra duty pay of 5s. per day.

It will thus be seen that the highly technical man is in receipt of 6d. per day less than the proved failure, who needs, for the work he is called upon to do, no higher qualifications than those of the average unskilled clerk. The injustice of this must be apparent to the simplest mind, but it has evidently been overlooked by the Army Council, who, it would appear, mete out remuneration according to "demerit." Why the I.O.M., who has charge of the most important machinery of our armies, and is responsible for its efficient working, should not be dignified with the rank of captain like his brother professionals on the medical staff, one cannot imagine, for his work is of the greatest and most serious importance; while the medical officer has the fitness of the men to ensure, and to heal their wounds, the I.O.M. has to do the same for the guns which are protecting the men from injuries; and hard, ceaseless work it is in times like these.

Surely some better recognition should be given to this highly qualified branch of the Service in these days when the war is largely a battle of engineering skill.

July 10th. J. C.

RAILWAY TRANSPORT.

SIR,—In your issue of the 6th inst. you state, in evident allusion to the scheme of the New Transport Company, that "The Goods Clearing House scheme is, as a whole, impracticable at the present time," &c. Your statement is quite correct and in order; but, having regard to the fact that you refer to Mr. Pratt's statement that the scheme of the New Transport Company is "impracticable," I feel it may be misunderstood to be an endorsement of Mr. Pratt's charge, which, of course, it is not.

I entirely agree with you that the Government have been "too late" in this all-important question of transport reform, but it is only fair to the New Transport Company to mention that the whole hideous business was placed before Mr. Winston Churchill, then President of the Board of Trade, in 1908. He did nothing. Neither then did the New Transport Company, nor does it now put forward any proposals which are not eminently practicable, so far as I and my co-directors are aware.

If, however, you are of opinion that an impracticable scheme, or a scheme which has features of an impracticable nature, is being placed before the public, it appears to me that exact reasons should be addueed in support of this opinion. The New Transport Company are at present issuing shares at a very high premium, but if you have any reason to suppose that the project of the Company is in any way unsound, and if you will disclose that reason you may rely that the board of the New Transport Company will immediately do everything in their power to amend their policy.

You will, I know, understand that if the allegations of Mr. Pratt are proved to be true, or to have any pretence of being true, the directors of the New Transport Company would be very seriously to blame. As at present advised we are content to prefer the advice of our consulting engineers, Mr. James Swinburne, F.R.S., and Dr. Hele-Shaw, F.R.S.

Acton, July 10th. A. W. GATTIE.

[This letter refers to a "Short Notice" of a year book by Edwin A. Pratt, entitled "A London Transport Trust."—ED. THE E.]

NOISE IN REINFORCED CONCRETE BUILDINGS.

SIR,—With reference to the above trouble I would suggest putting a layer of hard millboard under the padding beneath the machines, and also round the foundations of the machines. Should there be any columns passing through to the room below, they should be cased with millboard, or other sound-insulating material, both on the top floor and in the room below. This is very important, as sound is very readily conveyed by such columns. The walls in the neighbourhood of built-in columns might also be lined, and the floors also should probably be covered with sound-insulating material. S.

June 18th, 1917.

P.S.—The above was written some time ago in reply to a letter in THE ENGINEER of June 15th, and was mislaid, and the matter was recalled to my memory by a paragraph in this week's issue. On page 33, under "Miscellanea," ninth paragraph from the top, there is a method given of insulating floors with tar paper, which would seem to be suitable for Mr. Fryer's case. S.

July 14th.

EXCESS PROFITS.

SIR,—In your columns there are various discussions on the Act, so being vitally interested, may I be allowed to show how, in certain circumstances, the tax may centre on the individual.

Having invented a new type of machine it was put on the English market entirely on my own financial responsibility, where it met with a moderate degree of success. However, the business thus being primarily the buying and selling of machinery, it is presumably one "within the meaning of the Act." This point, together with several other weighty considerations, induced me to try the States, where now, having launched the proposition under the wing of a powerful firm, the question becomes acute as to the method of continuing on my own account. For the individual to be subject to a tax of 16s. in the £ on all over £100 a year, in addition to income tax, is rather a stiff proposition. Trusting that the case has been clearly presented.

June 25th. CLEVELAND MANCHESTER ENGINEER.

WAGON SMASH.

SIR,—I am sending you a photograph of a wagon smash that may interest you.

It was a runaway train of empties, and the leading wagon dashed into the stop blocks, which were practically destroyed, turned upside-down and nearly buried itself in the ground and *débris* of the stop blocks. The wagon following it landed almost wheel for wheel on the wheels of the upturned wagon, as you will see. The drawbars and couplings of the two wagons remained unbroken though badly bent.

SALT UNION, LIMITED.
GEO. W. MALCOLM, Managing Director.

Cheshire, July 13th.

A REMARKABLE WAGON ACCIDENT

COAL TRANSPORT REORGANISATION SCHEME.

IN connection with the above scheme the Controller of Coal Mines is considering the requirements of steam raisers as regards supplies of special coal fuel. Forms have been sent out to steam raisers throughout the country asking for information about the class of coal used, consumption, &c. A considerable number of the forms sent out have not been returned, and steam raisers who have received such forms should note that their requirements in the way of special fuels cannot be considered in the absence of the information called for by the forms, which should be filled in and despatched to the Controller of Coal Mines immediately. In cases where steam raisers have not received forms it is desirable that they should apply at once to the Contoller of Coal Mines, 8, Richmond-terrace, Whitehall, London, S.W. 1.

THERE will be no "summer train services" this year. The war has not, until this year, stopped their being put into force, although last summer the changes were fewer than usual. Shortage of power and men and the desirability of preventing travel as much as possible have made it necessary this year to "carry on" with the services brought into use in April last.

RAILWAY MATTERS.

ANSWERING a question by Mr. Field, the Chief Secretary for Ireland said that it was proposed to place the canals of Ireland under the control of a small committee, as had been done with the railways.

THE Irish seaside resorts of Portrush and Warrenpoint have sent a deputation to Mr. Duke to try and get the embargo on travel reduced. The Irish Secretary was very sympathetic, but confessed that he could not do more than refer the matter to the Irish Railway Executive Committee.

IN his early days Selous, the famous hunter, who recently died in German East Africa whilst fighting for his King, spent much of his time hunting big game in the vicinity of Gadzema and Hartley on the Rhodesian railways. In commemoration of this fact the railway administration has named a siding recently opened in that vicinity "Selous Siding."

IT is intended when Mr. A. Beasley retires from the position of general manager to the Taff Vale Railway Company, as intimated on page 33 of our issue of the 13th inst., to elect him to a seat on the Taff Vale Board. Mr. Beasley has been in railway service for sixty years, having been with the Great Western for thirty-four years prior to his going to the Taff Vale in 1901.

THE National Assembly of Panama has approved a contract made for the construction of a railway on the Atlantic coast of Panama, starting from the mouth of the river Chagres and running south-west for at least 50 kilom. to the City of Almirante. The concession is for seventy-five years, but the Government reserves the right to purchase the road after thirty years. The line has to be completed within five years.

IN a case in the King's Bench Division, the London and North-Western Company sued J. Sankey and Son, engineers, for the difference in the carriage of wheels for motor cars. The firm had sent them under Class 1, as wheels for cart and plough, iron or steel, but the company contended that they should be under Class 4—cart, coach, and carriage wheels. Neither party would appear to have been right, as such wheels are now carried under Class 2, but judgment was given for the difference in this case.

ON the 10th inst. the Under Secretary for War was asked whether there were many Belgian locomotives in good repair in France which were not being used; what was the reason why they were not used; and whether, in view of the depletion of locomotives from British railways, he would consider the desirability of making full use of all the Belgian rolling-stock, either by purchasing it or guaranteeing its replacement after the war. Mr. Macpherson said, in reply, that there is no considerable number of Belgian locomotives of suitable types in good repair in France which are not being used.

DURING the year ended June 30th, 1916, 5,149,289 train miles were run on the Government railways of Western Australia, this being 255,525 miles less than during the previous year. The gross earnings were £2,088,100—an increase of £29,866. The working expenses amounted to £1,511,655, this being an increase of £13,829. As there were 236 additional miles of line to operate, the smallness of the increase is regarded as having been satisfactory. The proportion of working expenses to earnings works out at 72.39 per cent., and represents a reduction of 0.38 per cent. on the previous year. The earnings were 97.32d. per train mile—an increase of 5.92d.; while the working expenses were 70.46d. per train mile—an increase of 3.95d. The net return per train mile was, therefore, 26.86d., but as the interest charges were 29.14d. per train mile, the actual result of working was a loss of 2.28d. per train mile.

As noted in this column of our issue of June 8th, a collision occurred on the evening of May 29th at the Newton Colliery signal-box of the Caledonian Railway between the 9.45 express from Glasgow to Euston—which was standing at the signal-box, owing to an up mineral train having broken down—and the ten o'clock from Glasgow to Euston. The signals at Hamilton Junction, 445 yards in the rear of the standing train, were against the second train, but it ran by them. The explanation given by the driver was that the brake failed to act properly, but there is no corroboration of this assertion. Although Colonel Pringle does not definitely say so, we read into his comments the suggestion that it was the explosion of three detonators which caused the driver to take action to stop the train, but that the full application of the brake was not made until he saw the tail lights of the standing train.

AT a meeting of the Western Division of the American Association of Railway Telegraph Superintendents, Mr. E. C. Keenan, of the New York Central lines, dealing with railway telephone developments, referred to some recent tests on the Cleveland, Cincinnati, Chicago and St. Louis railroad, of high resistance receivers on telephone despatching circuits designed to improve the transmission. This development, according to the *Railway Age Gazette*, grew out of the unusual conditions existing during recent months under the very heavy movement of traffic. On one-100 mile division on one day there was a goods train on every siding at the same time, and every operator was naturally listening on the despatcher's line in an attempt to keep the trains moving. This resulted in weakening the transmission so that the despatcher was very much hindered, and complaint was made. Tests showed that with the way stations cut out the transmission was normal, and the idea was, therefore, conceived of using a high voltage receiver at these stations to minimise the effect of leaving the receiver off the hook. Standard receivers used in wireless telephony were obtained, these being of the double type, with 1500 ohms in each receiver, making 3000 ohms across the line. The installation of these receivers in the thirty stations on this 100-mile circuit improved the transmission so much that it could be classed as good from end to end. Some laboratory tests were then undertaken with the receivers, and it was found that one 1500-ohm receiver, with a choke coil in series, gave equally good results, and the remaining receivers were, therefore, taken off and used on other circuits.

NOTES AND MEMORANDA.

LESS than one-third of the world's 700,000 miles of railways is State owned.

ON the canals between London and Liverpool there are nearly 200 locks. On the waterway between Berlin and Hamburg there are only three locks. This is an extreme contrast, but taking the canals of England and Wales altogether, there are 2377 locks for 3800 miles of waterways.

CENTERING for the 170ft. concrete arch span of the Myers Creek highway bridge, California, was supported on reinforced concrete sand-boxes 5ft. square with a 12in. by 12in. chamber 12in. deep filled with sand controlled by a 1in. outlet pipe. The centers were lowered by removing about one part of sand from the sand-box in each of twelve successive operations. The arch settled about ¾in. without cracking.

IN the House of Commons recently, the Chancellor of the Exchequer stated that the import duties derived from the taxation of motor spirit, apart from the sum realised by the Petrol Control Committee, were, for the years 1914–15, 1915–16 and 1916–17 respectively, as follows:—£944,648, £1,760,965 and £1,923,827. The increase in the duty on petrol from 3d. to 6d. per gallon as a war tax came into effect on September 22nd, 1915.

IN a large generating station having a good load factor, efficient turbine units, good super-heat and condensing conditions, and coal at normal prices, the generating costs per unit may be taken, says Mr. J. Shepherd, in a paper read before the Institution of Electrical Engineers, to be as follows:—Salaries and wages, 0.030d.; coal and ashes, 0.160d.; oil, waste and stores, 0.004d.; repairs to plant and buildings, 0.012d.; total, 0.206d.

MEASUREMENTS and calculations have been made on a large series of cut mountain ash timber in Victoria, and the general conclusion regarding the annual development of wood in this species of Eucalypt is that it reaches its maximum at fifty years, and that the most profitable time for cutting is between the sixtieth and seventieth years. According to *Nature*, these appear to be the first investigations of the kind made on Australian timber.

IT is only a few years ago that the car of engine dimensions which are now called 15.9 horse-power weighed, and was expected to weigh, less than a ton. To-day the average car of 15.9 R.A.C. rating weighs 25 cwt.—sometimes a little more, sometimes a little less—and with its passengers this car, as a rule, has a total weight of not much below 1½ tons. The additional weight is largely due to the improvements which have been added, says the *Autocar*.

ON the subject of aluminium pistons for internal combustion engines, Mr. Joseph Leopold, an American engineer with much experience of this class of work, advocates a plain sided piston of normal length, with circumferential grooves in the skirt, as distinct from the hour-glass or narrow-waisted type. It has only two rings above the gudgeon pin, the lower one having its groove bevelled and the bevel drilled through to the interior. A third ring is provided at the bottom end of the skirt.

ANALYSIS of a year's fires in New York State brings out figures rather uncomplimentary to the owners of the damaged property. Out of a total loss of some £4,000,000 no less than 21.7 per cent. is found to fall under causes wholly preventable and 31.9 to have been in part at least avoidable, while 46.5 per cent. is attributed to unknown causes. Defective chimneys, improperly exposed steam pipes, hot ashes or coals, are merely a few of many examples which might be given of the items which constitute the cause of an annual loss of £1,000,000.

RESEARCH has been spurred on in Canada by war necessities, by consideration of Germany's industrial strength and by recognition of the need of co-operation between science and industry. The movement, which is chiefly towards the elimination of waste, utilisation of by-products and adoption of new processes, is being directed by the Honorary Advisory Council for Scientific and Industrial Research of the Department of Trade and Commerce. Closer relations than have existed heretofore are being effected between the educational institutions and manufacturing establishments, so that Canadian college graduates may continue their training in the Dominion under actual commercial practice.

A CANVASS of the principal shipyards in the United States, made by *Marine Engineering*, on May 1, showed that 2,250,000 tons of merchant ships were under construction, 52.5 per cent. being built on the Atlantic and Gulf coasts, 33.2 per cent. on the Pacific coast, and 14.3 per cent. on the Great Lakes. The report comprised returns from 96 shipyards. In all, 723 merchant vessels were under construction. Three hundred and nineteen of these vessels, aggregating 1,539,354 gross tons, are freight steamships or motorships, 77 vessels of 365,488 gross tons are tankers, 10 vessels of 55,260 gross tons are passenger and freight steamers, and 118 vessels of 159,663 gross tons are wooden ships, either schooners or auxiliary schooners, while the remainder, or 199 vessels of 128,435 gross tons, are miscellaneous craft, such as barges, lighters, ferryboats, &c.

THE Japanese wireless telegraph station at Funabashi covers an area of about 110 acres. According to the *Wireless World*, there is a group of nineteen masts, the tallest, over 650ft. high, being situated in the centre of a ring of eighteen masts 260ft. high, which support the umbrella aerial. The outer masts are placed equi-distant from each other and 1300ft. from the central tower. The masts themselves are of triangular lattice form and rest upon ball-and-socket joints. They stand upon a concrete block, from which they are insulated by porcelain, the steelwork being held vertically by three groups of guys attached to the tower at four separate points. In the central tower there is 141 tons of steel. The prime mover is a Diesel engine of 500 horse-power, driving an alternator of 500 cycles, which in turn provide energy for a bank of transformers. The latter charge a battery of oil-filled condensers, which discharge through groups of quenched-spark gaps, and the gaps are cooled by blasts of air from a number of blowers. The transmitter is rated at 250 kilowatts.

MISCELLANEA.

THE Leicester Corporation has prepared a town-planning scheme to be put into operation after the war.

TENDERS to the Lambeth Borough Council for wood-block paving vary from £21 to £29 per thousand blocks as compared with a pre-war price of £9.

ALTHOUGH in this country it is usual to speak of football and cricket fields, when we speak of spaces devoted to flying we call them "aerodromes." Why not call them flying fields, as the Americans do?

TESTS with sirens for warning London of approaching air-raids having proved unsatisfactory, an air bomb producing a coloured smoke cloud was to be tested on Thursday afternoon. Up to the time of going to press we had heard nothing.

IMPORTANT Government changes were announced during the week. Sir Eric Geddes becomes First Lord of the Admiralty and Mr. Winston Churchill takes the place of Dr. Addison as Minister of Munitions. Dr. Addison has been appointed Minister for Reconstruction.

H.M. TRADE COMMISSIONER in New Zealand has forwarded an extract from the local Press, in which it is stated that an important find of scheelite has been made in the Barewood district. A Dunedin syndicate has secured an option and opened up the reef. Experienced miners are said to be of opinion that this is the richest and most important discovery of scheelite yet made in New Zealand.

THE supplement to the *Board of Trade Journal* of 19th July contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from British India, Australia, Canada, New Zealand, South Africa, Newfoundland, Egypt, Cyprus and Ceylon. Copies may be obtained at a cost of 3d.—3½d. post free—either from any bookseller, or from H.M. Stationery-office, Imperial House, Kingsway, London, W.C. 2.

JAPAN, with its innumerable bays, rivers, lakes, and canals, would seem to be an ideal place for small pleasure launches and moderate-size cruisers; but in reality the number of such boats is very small. The reasons are—(1) the fact that the Japanese have not yet adopted boating as a sport; (2) the high price of motors, and (3) the high price of petrol. No small high-speed petrol motors are said to be manufactured in Japan—a rather surprising fact in view of the pushfulness and mechanical genius of the "land of the rising sun."

A PRICE of 80s. per cwt., or but little short of 9d. per lb., is readily commanded by the rags of our Expeditionary Force, and the sale of them is limited to the fulfilment of Government orders. Given that the garment is of a certain age, its remains are worth more than the wool out of which it was made, says the *Journal of the Royal Society of Arts*. The price warrants the pains that are taken in the salvage, and at a time when towards 15,000,000 yards of new khaki are being put upon order the second-hand value is by no means negligible.

VARIOUS questions of a technical character having recently arisen relating to the supply of gas, the Fuel Research Board has undertaken, at the request of the Board of Trade and other Government departments concerned, to conduct an investigation, and to advise them as to the most suitable composition and quality of gas and the minimum pressure at which it should be generally supplied, having regard to the desirability of economy in the use of coal, the adequate recovery of by-products, and the purposes for which coal is now used.

THE Provincial Government of Ontario contemplates placing tractors at the disposal of farmers as a means of greater production The Government has about thirty-five district representatives in the more important agricultural counties of the Province, and apparently intends to place a tractor at the disposal of each of these representatives, to be used in assisting the farmer to plough and prepare his land for the planting of crops. According to the *Scientific American*, it is proposed to make a nominal charge per day or per acre, and to keep the tractors going day and night.

A GOOD deal of illness and distress has been incurred by handling bombs and parts of bombs dropped by the enemy aircraft, and to avoid it in future Dr. Sequeira, of the London Hospital, recommends that loose powder on such parts should be washed away with a copious supply of water, or with a solution of one teaspoonful of bicarbonate of soda in a quart of water. The parts should be handled with damp rags. not with gloves, which soon become impregnated with the poison and increase the harmful effect on the skin. Stains on the hands should be removed at once with pumice-stone and the soda solution.

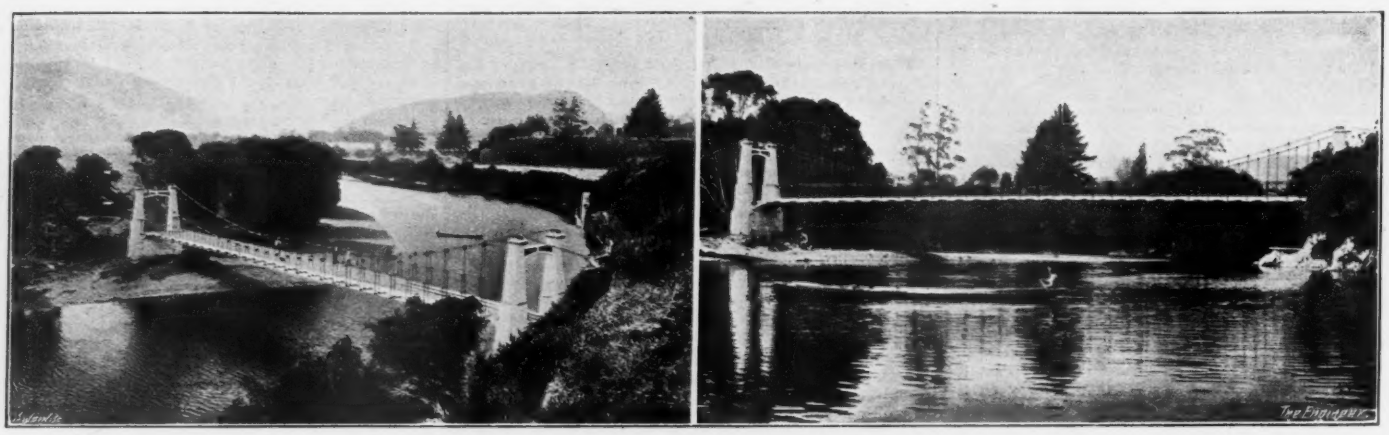
THE use of molybdenum as an ingredient for special steels is likely to be considerably increased as the result of experience gained during the war. The Germans have been using molybdenum steel in considerable quantities for their big guns, and the famous French "75" owes its long life to its lining of molybdenum steel. Tungsten steels, when used for the same purpose, were found to develop a coarse crystalline structure after a limited number of rounds had been fired, rendering the guns practically useless, says the *Ironmonger*. By employing molybdenum steel this defect has been overcome and the guns seem to last indefinitely.

WRITING in the *Iron and Coal Trades Review* on "Electric Steel Furnaces," Mr. E. Kilburn Scott says that many works that sell their steel swarf and scrap, cast iron borings, &c., at nominal prices and purchase all their steel castings, could very profitably install an electric furnace and make their own castings from the scrap. The charge can be made up entirely of scrap and turnings; no expensive raw materials are necessary. The melting loss is almost negligible, while, as already noted, in other processes it is from 7 per cent. to 15 per cent. The tensile properties of ordinary electric cast steel are:—Maximum tensile strength, 35 tons per square inch; yield point, 25 tons per square inch; reduction of area, 50 per cent.; elongation, 30 per cent.; while the maximum tensile stress can be readily increased to even 100 tons per square inch by the introduction of special elements such as nickel, chromium, and vanadium.

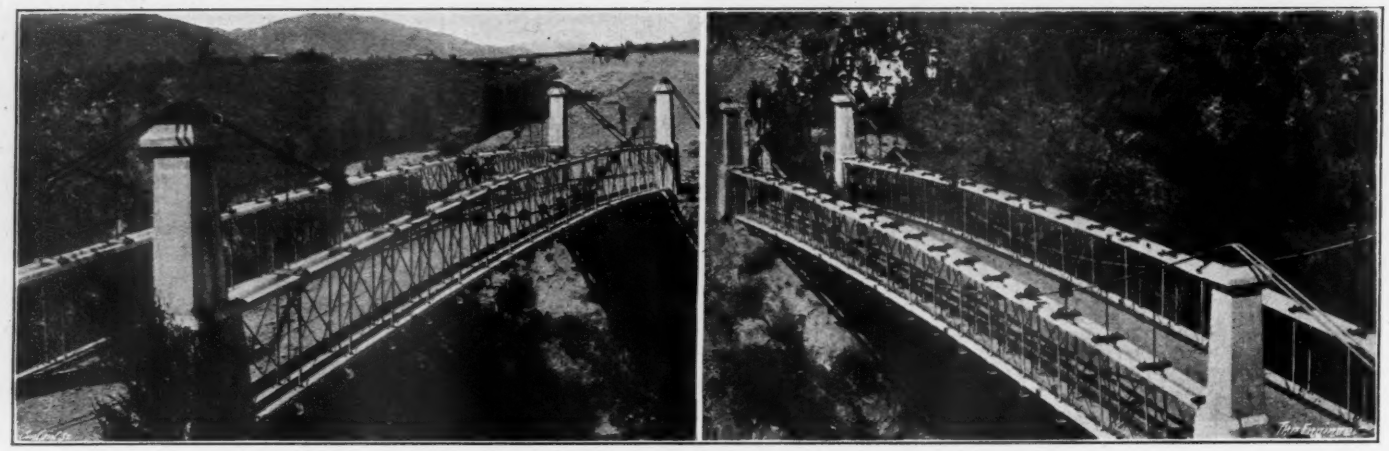
SUSPENSION BRIDGES IN NEW ZEALAND

MR. JOSEPH DAWSON, PAHIATUA, ENGINEER

(*For description see page 52*)



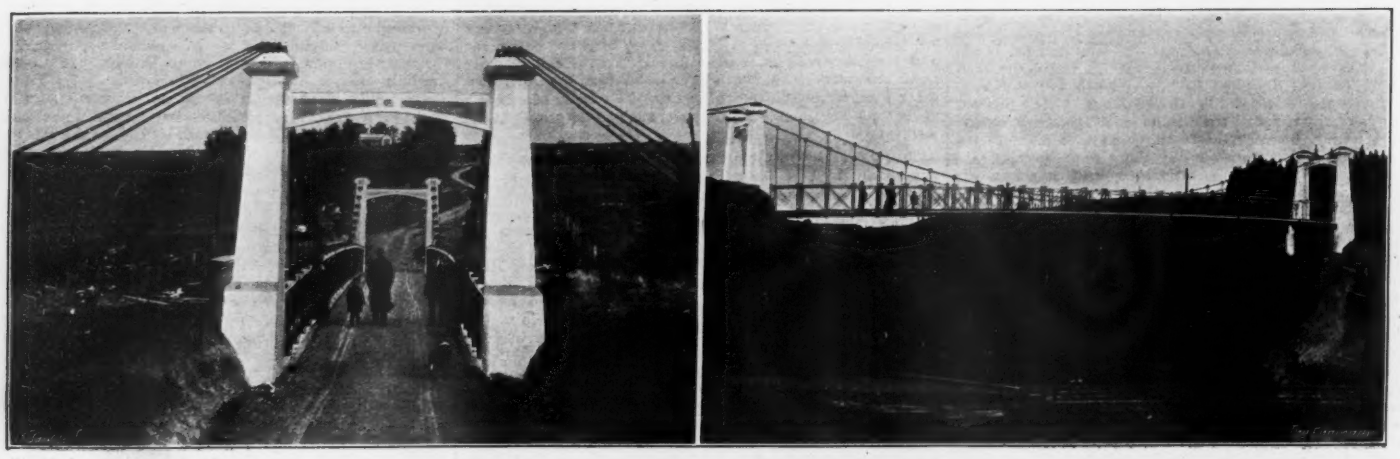
Figs. 3 and 4—UPPER HUTT BRIDGE, SPAN 170ft., WIDTH 12ft.



Figs. 5 and 6—UPTON DOWNS BRIDGE, SPAN 96ft.

Fig. 7—BRIDGE AT UPTON DOWNS, SPAN 80ft.

Fig. 8—BRIDGE AT ASHLEY-CLINTON, SPAN 165ft.



Figs. 9 and 10—BRIDGE AT ASHLEY-CLINTON, SPAN 156ft.

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TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

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THE ENGINEER.

JULY 20, 1917.

The Vanguard Disaster.

OF its kind, the destruction of H.M.S. Vanguard, apparently by an internal explosion, is the greatest naval disaster we have had to deplore since the commencement of the struggle. Many ships have been lost in action, notably at Jutland, where in the space of a few hours three great battle-cruisers and three other large armoured vessels went to the bottom under a rain of German shell. But losses incurred in actual fighting, heavy though they must always be in the intensive fighting of to-day, seem less tragic than those we suffer through causes other than direct enemy agency. Unfortunately, the Vanguard is not the first warship we have lost in this way. The battleship Bulwark and the armoured cruiser Natal were destroyed with the same appalling swiftness as they lay quietly at anchor, as was also the auxiliary vessel Princess Irene. The Vanguard was a much more valuable ship than any of these. It is true she was not a "super-Dreadnought," and that although only eight years had elapsed since her launch, she had already been left far behind by the mastodons which constitute the spear-head of the Grand Fleet. But the class of which she was a unit is still reckoned among the first rank of the Dreadnought fleet, and her disappearnace has, undeniably, left a gap in our main battle line. The lost ship belonged to the Navy Estimates for 1907–08. Built by Vickers Limited, she was launched at Barrow in 1909 and completed the following year. She was one of three vessels known as the "St. Vincent" class, the characteristics of which followed in the main those of the "Dreadnought." According to Brassey's *Annual*, the displacement was 19,250 tons, and the turbine machinery of 24,500 shaft horse-power gave a speed on trial of 22.1 knots. The armament consisted of ten 12in. guns of a very powerful type, with an auxiliary battery of twenty 4in. quick-firers and three torpedo tubes. The total estimated cost of the ship, including guns, was £1,607,781, and her normal complement numbered 724. These three ships were, as a matter of fact, considered slightly inferior to the "Dreadnought" and the "Bellerophon" class. Their heavy guns were more powerful, but the ships themselves were of lighter construction and carried thinner armour than their four predecessors of the all-big-gun type. Tested by the usual formula for determining the tactical value of fighting ships, they were given a figure of merit rather below that of the German "Helgoland" class.

In view of the circumstances in which the Vanguard met her fate, we fear that no definite conclusions will follow the searching inquiry which is to be held. Most, if not all, of the officers who were intimately concerned with the ordnance equipment of the ship have lost their lives, so that theory and surmise will have to be dealt with in default of first-hand evidence. As is usual in disasters of this kind, one hears a great deal of talk about treachery. The responsible authorities may be in possession of facts which are not available to the public, and the secrecy that is essential in war-time renders it idle to indulge in speculation where no proved facts exist. When the Bulwark was blown up in the early stage of the war, the possibility of sabotage was accepted by a good many people, but, subsequently, there was an official announcement of the finding of the court of inquiry which showed the disaster to have been due to a pure accident. In the case of the Natal, no second announcement was ever made, a fact which was held in some quarters to confirm the popular theory of a German plot. On the whole, however, we are not inclined to attach much credence to the supposition that hostile emissaries are responsible for the loss of these ships. Cunning and utterly unscrupulous as we know our enemies to be, they would find it a matter of extreme difficulty to accomplish by underhand methods the destruction of a British warship, especially if it happened to be a member of the Grand Fleet. The Navy is thorough in all that it does, and in nothing is it more thorough than in the precautions it takes against espionage. In theory it may be simple enough to think out divers means of perpetrating acts of sabotage, but in practice any such attempt would encounter formidable difficulties. Therefore, while the possibility of treachery cannot be ruled entirely out, we are disposed to share the more prosaic opinion that the loss of the Vanguard was due to an accident. Few who have considered the matter at all can have failed to marvel at the rarity of these naval disasters. Every warship, great and small, is a potential volcano. Vessels of the battleship type carry deep down in their hulls hundreds of tons of the most violent explosives, and the slightest oversight, not to say negligence, in the handling, housing, or care of this deadly cargo may be fraught with the most terrible consequences.

Before the war, our Navy was singularly free from such misfortunes, an immunity which was no doubt largely the result of the painstaking care exercised in the manufacture and storage of ammunition. But what is customary in peace may not always prove practicable in wartime. Nevertheless, considering the extraordinary circumstances, the quality of our munitions has been astonishingly high, and it is steadily rising, as we have learnt from recent statements by members of the Ministry of Munitions. The chemists, the engineers, and the factory hands are fully alive to the supreme importance of putting in the very finest work in their respective spheres while they are engaged in supplying our gallant sailors and soldiers with ammunition. And, in fact, officers of both Services have repeatedly testified to the uniformly good standard of the explosives they receive from the home factories. The percentage of defective material has become almost infinitesimal. In land operations, an accident due to a defective cartridge or shell is rarely very serious in its consequences. But, at sea, the conditions are wholly different. The decomposition of a single 4in. cartridge may annihilate the mightiest battleship.

The fact that disasters similar to that of the Vanguard have occurred in many navies during the war supports the theory of accident as opposed to that of deliberate agency. Two Italian battleships, the Leonardo da Vinci and the Benedetto Brin, were destroyed while in harbour; the Russian Dreadnought Imperatriza Maria and the Japanese cruiser Tsukuba shared the same fate. No doubt, similar calamities have befallen the enemy fleets. They are part of the inevitable toll of war. Every fighting ship in every belligerent fleet is kept perpetually in a condition of instant readiness for action. Visits to the dockyard for repair and overhaul are only made when they become absolutely necessary. The ships are always under steam, and the problem of maintaining an equable temperature and proper ventilation naturally becomes far more complex than in peace. When not on active service, a warship does not generally have her magazines full. In wartime she carries her maximum supply of ammunition. These and many other equally pertinent facts deserve to be borne in mind, since they go far to explain why—happily at very long intervals—we have to mourn the loss of a fine ship and her gallant company through causes in which the enemy has no visible part. So far as the material aspect is concerned, the loss of the Vanguard is not irremediable. She represented a type in which we are exceptionally strong, and her disappearance does not mean any serious diminution in our margin of superiority over the armoured strength of the German Fleet. The grievous feature of the disaster is the loss of nearly 850 officers and men, the fine flower of their race. This terrible death-roll is the best proof that everyone was at his post, and died as nobly as if he had fallen in action against the foe. We may rest assured that everything that human skill and care can do will be done to avert a repetition of this sad occurrence, which has served as a reminder of the ever-present risks which threaten our fighting seamen, whether at anchor or facing the enemy's guns.

The Taxation of Stock Valuations.

THE concession gained for manufacturers in the House of Commons on Monday, when the Finance Bill came up for consideration and report, was the second. The first resulted in the issue of a White Paper explaining fully the Government's proposals upon the valuation of stocks for the purposes of excess profits duty. This document provided that "a period will be allowed after the termination of the war in which to ascertain by actual realisation the value of the stock appearing in the account at the end of the last accounting period, and an allowance made from the profits of that period for any difference

between the valuation and the sum realised. The period proposed is a fixed period of a year from the termination of the war, for all businesses." The White Paper followed a protest by a group of manufacturers who believe that but for the steps they took at that time the Bill would have slipped through as it was, unamended. Their position then would have been infinitely worse than under the modifications revealed by the White Paper, which formed the subject of consideration in the House on Monday. But even in its revised version form, that portion of the Bill relating to the method of taxation of stock valuations seemed quite unacceptable to the great iron and steel interests of the country, and no less so, presumably, to other industrial concerns. What they contended was that the period of one year after the war was vague. Not only was it vague, it was wrong. To give definiteness the clause should have made the period the next accounting period or periods after the cessation of the excess profits tax. Simply to speak of a year was no concession at all. Could labour conditions, raw material supplies, and carrying tonnage adjust themselves to anything approaching the normal in the short space of twelve months from the firing of the last shot? So argued the manufacturers, and they must have stood upon fairly solid ground, for Mr. Bonar Law expressed his willingness to extend the period of realisation to two years.

But this half-loaf concession appears to have left the iron and steel firms almost as dissatisfied as before. Certainly the amendment, so ably seconded by a member who was perfectly familiar with the needs of those for whom he spoke, and who presented their case with an earnestness and courtesy which did not pass the notice of the Chancellor, was withdrawn, but other anomalies remained. There was still that portion of the first clause in the White Paper which provides that "the loss—if any—on only such stocks as were in hand at the end of the last accounting period will be brought into the adjustment, but the whole of such stocks, not individual parcels selected by the taxpayer, must be considered." Upon this point the "taxpayer" asks why cognisance is not taken of the large normal stock that has of necessity to be carried by all manufacturing concerns? This floating stock, which is drawn upon and replenished from day to day and never permitted, in any well-regulated business, to fall below a given level, is one of the guarantees to Labour of continuity of employment. It is the soul of industry. In that way there are large numbers of firms whose normal stock runs to several thousands of tons of steel. Their custom, perhaps, has been to book this stock at a flat rate, thus regulating matters by obviating an apparent enormous profit being shown in one year, and a loss, it may be, in another. In the interests of the Government, as "controlled" businesses, these firms have increased their working stock, and protest against being taxed upon what they contend would be purely and simply paper profits, meaning for them an absolute loss of capital. As the head of one large concern puts it: "It is no remedy for the evil of forcing this base stock to an inflated value to provide for the realisation of the particular articles constituting the stock at the end of the accounting period. The owner is obliged to replace them by others equally, or almost equally, inflated in the period at which he is left to run the risk of losses resulting from inflation, unless he decides there and then, as far as possible, to liquidate his business and dismiss his workpeople."

Another objection of manufacturers is to the clause of the White Paper in which the legitimacy of the practice of taking a constant quantity of stock at a constant price is admitted, but is accepted only in cases in which the "recognised practice number obtained," and where the Government "would regard the goods as imperishable." Where individual judgment regarding valuation of stocks has for so long prevailed on a point of this kind, it is contended that to leave to the decision of the Board of Inland Revenue whether or not the claim of an industry to be brought under this concession should be allowed, would be to open the door to a feeling of distrust and discontent rather than to secure "uniform treatment of all members of the industry." Manufacturers, moreover, object to professional accountants becoming experts in valuation to the Government, as being quite contrary to their invariable practice, and would have no confidence in the advice thus tendered to the Government. The report stage of the Bill is concluded, but the firms which feel that advantage has been taken of them seem in no way disposed to give up the fight. There is, of course, such a thing as reducing stock to the barest margin, in which case the £100,000,000 would be difficult of realisation, and it is not impossible for controlled firms feeling aggrieved to call upon the Government to keep them in future supplied with the necessary raw materials for manufacture, thus obviating the carrying of stocks on their own account. We should not like to see either of these courses taken, but if firms are to continue their work in producing war material, and seriously to engage in preparations for reconstruction after the war, there should be removed from their minds the fear that inroads may be made upon their capital as well as on their excess profits. It is impossible to suppose that Labour calls for this sacrifice in return for its suspension of union rules, and if the Government has sufficient doubts about the proceeding to make provision for cases in which "owners should not be left with the whole of the loss when the natural reaction comes, and they are selling on a falling market," ought it not in common justice, even now, to reconsider that part of the Finance Bill?

The London County Council Tramways.

The financial condition of the London County Council Tramways, as set out in a report of the Highways Committee, dated July 12th dealing with the year ended March 31st last, would appear to show an improvement as compared with the figures of the year before. There is, certainly, on the face of things, an amelioration; but when matters come to be critically examined, the change for the better is more apparent than real. However, let us not disdain the small crumbs of comfort which the accounts offer. To begin with, then, in place of a deficiency of £74,092, which the Highways Committee estimated would result from the year's working, there is, after meeting debt charges, &c., a surplus balance of some £11,342 odd to be transferred to the Renewals Fund. The total income was £2,552,204, as compared with £2,339,291 in the preceding year—an increase of £212,913; while the working expenses were £1,817,694 as compared with £1,683,660 during 1915–16—an increase of £134,034. The net result, therefore, was that during the year 1916–17 the tramways actually made nearly £79,000 more than they did the year before. It is not clear from the accounts as presented exactly to what this increase in net revenue is due, but it is a fact that in 1916–17, 40,704,579 more passengers were carried than in 1915–16. If each of these 40 million odd passengers were taken as bringing in as much money in fares as is represented by dividing the total passenger traffic receipts—£2,476,309—by the total number of passengers carried—586,127,976—it would seem at first sight as though the increased revenue should have been nearer £179,000 than £79,000, but it must not be forgotten that in 1916–17 the running expenses were higher than in 1915–16, owing partly no doubt, to the fact that in the former year nearly 1,600,000 more car miles were run than in 1915–16, the actual figures being 49,478,973 and 47,879,675 respectively. The passengers carried per car mile, which had been 9.33 in 1914–15 and 11.4 in 1915–16, further rose to nearly 11.85 in 1916–17; while the receipts per car mile, which had been 9.77d. in 1914–15 and 11.42d. in 1915–16, rose in 1916–17 to a shade over 12d. Yet, in spite of this increase in receipts, the fact remains that after making deduction for debt charges and sundry adjustments, into the details of which it will not be necessary for us to go, there remains but the comparatively paltry surplus of £11,342 10s. 3d. to transfer to the Renewals Fund.

Small though it is, however, it is to be looked upon with a certain amount of satisfaction, since the move is in the right direction. It is, however, but a drop in the ocean, when regarded from the standpoint of what it should have been in order to make the position financially sound. To explain why this is so, it is necessary again to discuss the question of renewals. The Council, after disregarding the matter for a number of years, eventually decided to lay by the—according to many authorities, totally inadequate—amount of two-thirds of a penny per car mile. We will not weary our readers by again going over the tiresome history of the Fund. It will suffice to say, that eventually it was found impossible to put aside even this amount, and that for the year 1912–13 the renewals fund only received the insignificant contribution of £497. Since that time until the present year the Fund has not received a penny as the result of the working of the tramways, and, meanwhile, the following amounts have been spent on renewals:—1912–13, £39,677; 1913–14, £114,987; 1914–15, £141,813; 1915–16, £73,255; and 1916–17, £68,251. These sums represent a total of £437,983, and against them have to be ranged only the £497 of 1912–13 and the £11,343 of 1916–17, or a total of, say, £11,840. Even on the basis of two-thirds of a penny per car mile, the contribution to the Fund, as the result of last year's working, should have exceeded £137,000. Moreover, a distinctly disquieting aspect of affairs is revealed by the amounts actually expended on renewals. From the £39,677 expended in 1912–13, there was a sudden jump to £114,987 in 1913–14, and a further increase to £141,813 in 1914–15. In the nature of things, it was to be expected, having regard to the fact that the tramway equipment was a year older, that more would have been required in 1915–16 if everything were to be kept in proper order, but in the two years 1915–16 and 1916–17 a total only just in excess of the 1914–15 figure—to be precise £141,506—was devoted to renewals. Moreover, the estimate for the current year is only £88,180. These figures point to one of two conclusions:—Either that a good deal more was spent in 1914–15 than there was any occasion for; or that enough is not being spent now, nor has been for two years past, to keep the equipment in proper running order. In our opinion, the latter conclusion is more likely to be an accurate representation of the facts than the former, and, if we are right in this view, then worse trouble may be looked for in the future than has been experienced hitherto; for there will come a time when the work which, we imagine, is now being neglected, will have to be done. When that time arrives, it will be found that the renewals will cost much more than would have been the case had they been effected at the proper time.

The position of affairs, apart altogether from this particular point, is, moreover, far from being satisfactory. In its original estimate for the result of working during the year 1917–18, the Highways Committee anticipated an estimated deficiency of £89,402. This estimate was formed during the early months of the year. In the intervening period it has seen cause to alter its views, and it now considers that instead of this deficit there should be a surplus of £8598. But what is that sum compared with the amount represented by two-thirds of a penny per car mile on the total number which will be run, say, about 50 millions? It is not even one-tenth as much as the £88,180 which is to be spent during the year on renewals, and regarding the sufficiency of which we have grave doubts. It must be said, however, that, as far as actual receipts are concerned, there is a tendency to increase. For the period of 1917–18, from April 1st to the present time, the increase in traffic receipts as compared with the same period of last year, is £92,562. This increase has been realised in spite of a diminution in passengers carried, amounting to 843,532, or some 3¾ per cent., but is, no doubt, accounted for to some extent by the fact that ½d. fares and ordinary return tickets were suspended towards the end of May. If the increase could go on for the remainder of the financial year at the same rate, and if the working expenses were to remain at the same level as during the past year, then it might well be that the takings would be enough to permit a sum represented by two-thirds of a penny per car mile to be carried to the Renewals Fund. It would appear, however, judging from the fact that the 1916–17 working expenses were £134,034 more than in 1915–16, most likely that the working expenses of the present year will show an increase. The Highways Committee itself evidently thinks that they will, since it does not look for a greater total surplus for the year than £8598; though in fairness it should be pointed out that, apparently, the increase in traffic revenue is greater than had been anticipated. At the time the alteration in fares was made, it was estimated that the total increase in revenue it would effect by the end of the financial year would be £87,500. This sum has, as we have shown, been already passed. Still, though, as far as it goes, the increase is good—and it shows, incidentally, that ½d. fares and return tickets at cheap rates do not pay—the situation is a long way from being sound. The Renewals Fund—taking no account of the depreciation in the market value of the stocks held—was estimated to be £282,978 at the end of March last. At the end of next March, it is calculated that it will have been reduced to £200,112—again taking no account of the depreciation in investments. The General Reserve Fund, at the same time, will, it is estimated, be £74,919, with the investments taken at cost price. These figures, regarded in conjunction with the fact that in all likelihood sufficient is not being spent on renewals, certainly do not point to a condition of prosperity in the Council's tramway undertaking.

The Latent Heat of Steam.

To-day we conclude a series of three articles on the Latent Heat of Steam. Even in these days, when the thoughts of engineers are turned rather to practical than to theoretical questions, when their first and their last anxiety is to increase the output of standardised material required by our armies, and little or no time can be spared for the consideration of a subject that will not effect, in even the smallest

measure, the working of machinery, we may venture to hope that these articles will be read, digested, and discussed. They present, we believe, the first definite challenge to Regnault. Others, indeed, in recent years, may have had their doubts about the variability of latent heat, but it was left to Mr. Frank B. Aspinall to put the question to the test of actual experiments. Those experiments have led him to the conclusion that the latent heat of steam is constant. They cannot be lightly disregarded. It would be grossly unfair to say that because Mr. Aspinall is not widely known as a physicist, because his ability as an experimentalist has not been proved, or because he holds no high and honoured position in one of our learned societies, that, therefore, he has no right to set himself up in opposition to Regnault and to challenge a dogma that the scientific world has accepted for many a long year. Mr. Aspinall may be wrong, the deductions he makes may be false, he may have fallen into an error in the arrangement of his tests. Even so it is only right that he should be given a fair hearing. He is a scientific man working for a scientific purpose in a scientific way, and he should be treated with the same considerations that would be extended to the highest scientist in the land who advanced a heterodox theory.

We say this because some engineers with whom we discussed the articles sought to dissuade us from the publication of them. They were tied to the old dogma, they looked with apprehension on anything that might upset all the thermodynamics of the steam engine on which they had been brought up; they thought it unwise to unsettle students by suggesting, even, that Regnault might, after all, have made a mistake. We could not countenance such views. The truth is of far greater consequence than the ease of mind of thermodynamicians and students; if Aspinall is right then Regnault was wrong; that was all that mattered to us. We had, none the less, our own anxiety. We should have been guilty of a grave fault if we had allowed our pages to be used for the circulation of a disturbing theory were it not well founded. We had then to satisfy ourselves that the new theory was worthy of consideration, and we had to take care that it was advanced in a calm and logical spirit. Mr. Aspinall wrote a great deal more than we have published; but when we put our views before him, he, in the readiest way possible, accepted them. The attitude we took up was that the inductive method could be alone relied upon. The force of his arguments must rest in experiment and experiment alone. Deductive reasoning, we felt, could never convince anyone that the latent heat of steam was a constant in face of Regnault's measurements. The only thing that could convince would be new and better measurements. For that reason we asked Mr. Aspinall to concentrate his whole attention on his experiments, to explain fully the plant he employed, and the methods he followed. If, then, he had fallen into an error it could be discovered by anyone who cared to examine his results. At one time we proposed to give all his figures, and in a normal year we might have done so, but under the present restrictions and difficulties we had to be content with a few typical examples. Mr. Aspinall has all the tables, and we have no doubt will be glad to show them to anyone who may be really interested. In any case we give enough to show that the experiments were carried out with great care. That they were made under the eye of a man so well versed in the delicacies of experiment as the late Dr. Silvanus Thompson adds to their weight. The tests and the plant described are not the only tests Mr. Aspinall has made, or the only plant he has used. He had reached a similar result in a different way, but we were not satisfied with it. There was, what seemed to us, an obvious chance of error, and it appeared to us better not to advance it. We quite candidly admit that there may be a fault in the present method that has escaped us; if so we shall be delighted to have it pointed out to us. If no fault can be found with the method, then the supporters of Regnault must show either that the figures are wrong or that the deductions from them are faulty. We have made inquiries, and as far as one may be satisfied on such a point, we are satisfied that the figures are right. Are, then, the deductions wrong? That is the question we put to our readers. If they are it is of great scientific importance that the error should be pointed out.

We are here dealing with facts and the meaning of facts. It is quite possible to give reasons why the latent heat of steam must be a variable, or equally to give reasons why it may be a constant. But with them we have little or nothing to do. The fact here is that in a very carefully conducted series of experiments, a series of experiments in which it was endeavoured to remove every source of error, figures were obtained which seem to indicate that the latent heat of steam is a constant. Unless those figures can be overthrown serious doubts must rest upon the accuracy of a dogma in which we have all been brought up, and it will be the obvious duty of scientific men to put that doubt at rest by new determinations or by a repetition of Mr. Aspinall's trials.

LITERATURE.

The Range of Electric Searchlight Projectors. By JEAN REY, Ingenieur Civil des Mines, Lauréat de l'Institut. Translated by J. H. Johnson, M. Inst. E.E., Assoc. A.I.E.E. London: Constable and Co., Limited. 1917. 12s. 6d. net.

WE are all deeply interested in searchlights nowadays. A few years ago watching their beams was a recreation pursued in exhibitions and harbours. Now we study them with different feelings. When they appear at certain hours we say to ourselves "All's well, there are no enemy aircraft about;" at other times we know they bear the opposite message. But at all times they are full of fascination, and to the enquiring mind, full of problems. On some nights they appear to have no beams at all, on others a great arm of light stretches out into the clear vault in an arch which reaches perfection and magnificence when it coincides with an opposing beam and closes the circuit from horizon to horizon. It seems strange that the beam should be bent until we remember the refraction of the atmosphere. Then, again, if one stands close beside a projector the beam looks extraordinarily short and powerless; to the actual operators it is little more than a disc, since they are looking straight along it. Walk approximately parallel to the beam, and not far from it, and its end keeps pace with you, marching forward a short way ahead of you and continually lengthening, just as if the operator were purposely following your path. Here we have quite an interesting problem in the angle of reflection of light from the moisture and dust of the air. Again, we have heard people express surprise because the beam lighted up the road at their feet. How they could see it if it were not dispersing light sideways is a question that had not occurred to them. We have heard others speak of the beam as lengthening and shortening—an effect due mainly to a change in the angle of projection—as if the operator were endeavouring to focus it on a certain depth in the atmosphere. Needless to say, he has no power of doing so; the beam is, if not parallel, not convergent, and stabs always as far into the darkness as it can stab. How far that may be is the question with which this book deals.

It might be thought a useless question because the transparency of the atmosphere is constantly changing, and whatever we may achieve in the way of calculations must be tempered by a factor for this unknown degree of resistance. But whilst it is certain that no formula can really help us to say how far the beam will carry at all times it will tell us the degree of illumination at given distances from the projector under given circumstances, and that is very useful knowledge. The examples which Monsieur Rey gives in an appendix to his translation bring out its value admirably. He tells us of a case of an aviator who believed he was visible to the enemy twelve kilometres distant in the beam of a searchlight. Now it is known that the largest searchlight used by the Germans in the field is 1.10 metres in diameter, and that under the most favourable conditions it gives an illumination of 50 lux at 1000 metres With these facts, and a simple calculation, for the making of which this valuable book provides the material, it can be shown that the illumination thrown on the aeroplane was 0.05 candle-power, or just about one-fourth that which would be given by the full moon at its zenith. "Such an illumination makes it possible to see the time on a watch, and it is readily comprehensible that an observer, placed within a beam giving that degree of illumination, must feel that he is discovered by the enemy, whereas the latter, at a distance of twelve kilometres, is absolutely unable to perceive him." In another example worked out in the appendix we are told of a group of men working at a trench about five miles from the enemy, and taking cover from a searchlight. As a matter of fact the illumination on them was less than .3 lux, not sufficient to reveal men to an enemy at the distance named, even with the best field glasses.

Another interesting question that is connected with this problem is the effect of the area of the illuminated object. The bigger the object the more light it will reflect, and the more likely is it to be seen, but if its distance is such that it subtends to the observer only one minute of arc it will at the best appear only as a spot of light, and its shape will be indistinguishable. Putting these facts together we may see that a searchlight may have the greatest difficulty in picking up and holding aircraft in its beam. Indeed, although an observer closer to the aircraft than the searchlight might see it illuminated, it might be wholly invisible to the operators themselves. We see the same thing in a very big example. Our moon is very visible to us, but a human observer placed near the sun would be as unconscious of its existence as we are, by the unaided sight, of the moons of Jupiter.

The most important chapter in the volume is that entitled "The Law of Range," in which M. Blondel's formula is analysed and discussed. As it has been checked and confirmed by extensive practical tests it may be accepted, but we must confess that in one respect we are unable to follow the reasoning. Amongst other factors the illumination of an object is made inversely proportional to the square of its distance from the source of light. That is, of course, the ordinary law of radiant energy, but we fail to see how it applies in this case. "It is well known," says Mr. Rey, "that the luminous flux which emanates from a searchlight has the shape of a cone with a circular base. The working area of the various straight sections of the cone, perpendicular to the axis, therefore goes on increasing as the square of the distance to the *summit of the cone*, and as these sections are all traversed by the same luminous flux, the result is that the illumination of each section, that is the flux per unit of surface, decreases with the square of the distance." We are responsible for underlining the words *summit of the cone*. If the distance were measured from that point, which is, in consequence of the very small divergence of the beam, miles behind the searchlight, then there could be no quarrel with the formula, but the distance taken is *l*, and the diagrams show that that is the length between the searchlight itself and the object. Now a very little consideration is needed to see that the square-law does not apply, under these circumstances, to the beam from the searchlight to the object. On the other hand, it is true if the beam reflected from the illuminated object to the observer, and Mr. Rey explains the curious anomaly that nevertheless the visibility is directly proportional to this distance, and not inversely to its square as we should expect. "The luminous flux per unit of surface, which emanates from the object illuminated and falls on the retina, decreases as the square of the distance, or as the square of the angle subtended by the object. However, as the surface of the retinal image also diminishes as the square of the same angle, the illumination per unit of surface of the retinal image therefore remains constant." We shall be obliged if Mr. Rey or Mr. Johnson will indicate the error in our view of their formula if we are guilty of one; or, on the other hand, would show why the formula gives accurate results if there is indeed a mistake in the argument. The correct expression should, we think, include the area of the projector, for since the beam approaches parallelity, this area is too large a factor to be disregarded, as it might safely be in the case of a very divergent beam. We have worked out what we believe to be the correct expression, but must admit that it is extremely cumbersome, and a shorter approximation would be welcomed.

A part of the volume that will appeal most to the men in charge of searchlights is that devoted to practical problems of ranges; here we find such useful things developed from the figures and large scale diagrams that are given, as the "Determination of the Practical Illumination of a Searchlight, where the Range for a Specified Objective is known, and also the Co-efficient of Transparency." Under this heading the illumination of ports, batteries, bodies of troops, torpedo-boats, black buoys, &c., is worked out. In another chapter "the variation of the range according to the size of searchlight and the atmospheric transparency" is discussed. It is here pointed out that if "it were desired to obtain ranges much greater than those obtained at present, it would be necessary to have searchlights of abnormal diameters, which would be quite immobile and unable to follow armies on active service or for warlike operations on land." For ship work and for fixed lights there would be less difficulty, but then we should be faced by the problem of finding suitable carbons of large size, a very practical difficulty that has not yet been satisfactorily solved.

Altogether this is a very valuable and practical book, and one that will undoubtedly be popular in our forces at sea and on land. Mr. Johnson has done his work of translation well, and has managed to avoid falling into the French idiom, but we could wish that he had been equally successful in avoiding split infinitives of the order "to always simultaneously measure."

BOOKS RECEIVED.

Treatise on Hydraulics. By Mansfield Merriman. Tenth edition. Messrs. Chapman and Hall. 18s. 6d. net.

Science and Industry. By R. T. Glazebrook. London: Cambridge University Press, Fetter-lane, E.C. 4. 1s. 6d. net.

Records of Railway Interests in the War, Part IV. British. *The Railway News*, 91, Temple-chambers, Temple-avenue, London, E.C. 1s.

Steam Turbines. By James Ambrose Moyer. Third edition. Messrs. Chapman and Hall, 11, Henrietta-street, Covent Garden, W.C. 2. 16s. 6d. net.

THE Defence Department of the Australian Government proposes to erect plant for the production of benzene and toluene in the Commonwealth. The crude benzole to be treated will be obtained from the various Australian gas companies.

THE DETERIORATION OF CURTIS RATEAU TURBINE BLADING.*

By A. FENWICK, Member.

(*Continued from page* 32.)

STATIONARY BLADING.

Inlet Nozzles.—Commencing first with the inlet nozzles, these are of cast iron on all the turbines dealt with. Fig. 6 shows the upper section of inlet nozzles for one of the 9600-kilowatt Rosherville sets. The separate nozzles or ports are divided from each other by a thin wall of cast iron, varying from 3 mm. to 5 mm. in thickness on the discharge side, and increasing in thickness as the nozzle assumes the circular section at the inlet side. Fig. 7 shows one of these nozzle sections cut down the centre. As supplied by the makers, these nozzles are not at all satisfactory, the dividing pieces or vanes crack badly, and frequently large pieces break out and pass through the turbine; this sometimes occurs after a few thousand running hours, and has been the cause of much anxiety and frequent examination. Usually, beyond slight bruising of the blades, little damage is done, but there is always the possibility of serious injury to the blading, and it is highly probable this was the cause of a partial strip on one of the sets. It is not an easy matter to locate the cause of many blading troubles, as a piece of metal will frequently pass through several stages and leave very little trace before becoming finally jammed about the centre or towards the exhaust end of the machine.

Fig. 8 shows the appearance of a set of nozzles from one of the Rosherville 9600-kilowatt sets after being in use for 3000 hours. Every vane is cracked, or broken, but if pieces were knocked out of the two upper vanes, which are apparently sound, and loose portions chipped clear, the nozzles would be perfectly safe for running purposes. The two vertical marks seen in the whole vanes are not cracks but saw cuts, and were put in to prevent the damage referred to, but very little improvement, if any, was effected. The photograph is hardly representative of the condition of inlet nozzles after a running period of 3000 hours; usually two or three vanes only in each section have pieces broken off after that running period.

One would naturally think that with a nozzle damaged in this way a considerable falling off in efficiency would result; this, however, was not noticed, and led to a test being carried out with a particularly bad set of nozzles. The result of this test showed that the turbine was as efficient as if nozzles in good condition had been used; it was obviously sound practice, therefore, to remove that part which invariably broke away. A V-shaped portion was accordingly cut out before fitting the nozzles to the machine. Fig. 9 shows the idea, which has been carried out on all the main turbines, since when we have been practically free from breakage of nozzle vanes.

A good deal of bulging and distortion still takes place, due to the expansion and permanent growth of the cast iron; cracks also develop frequently at the apex of the V, but the vane adheres to the nozzle cheeks and usually does not break off, as was formerly the case.

Cast iron is far from being the best material for inlet nozzles, but it is no doubt very much cheaper in the first place than anything else, and, for this reason, should receive some consideration before being discarded. A further experiment has been tried, namely, steel blades, forged from mild steel bar to the same shape as the cast iron vane and cast into an iron body. The analysis of the steel is not known, but the bar is of ordinary commercial quality. This nozzle was made locally, and has been running on one of our large (9600 K.W., Rosherville) turbines for over 3000 hours. When last examined it was in excellent condition—in fact, as good as the day it was first put into commission, and should further use fail to disclose defects in this type of construction, the idea is well worth adopting. There are no thin pieces of cast iron to break off, and although a V-shaped portion is cut out of the vanes in the cast iron nozzles previously described, and additional safety is thereby attained, there is still the chance that a piece of the remaining portion of the vane may break away and do a lot of damage.

There are two exceptions to the general rule of cast iron nozzles on the plant installed at the power stations; one on a small compressor turbine built by Pokorny and Wittekind, in which the nozzles are neatly carved out of a steel block, and the other on a condensing set turbine built by W. H. Allen and Co., the nozzle in this case being of steel, machined and inserted in a cast steel body. These two turbines are not dealt with in this paper. In both cases the result leaves nothing to be desired, and this metal is probably as suitable as any at present in use by turbine builders.

Bronze castings have been used by some manufacturers,* but the author is not aware of the composition.

Brass would probably be too soft. Monel metal might prove suitable if it would stand the high temperature and give a good, clean casting. Steel castings would be difficult to make on account of the thin dividing pieces, and it is doubtful whether a sound, smooth casting could be produced.

Curtis Stationary Segments.—Four metals have been used for the blading of Curtis stationary segments, and details of the results when fitted to the various classes of turbines are given below.

1. *Aluminium Bronze* (*L*).—This metal was originally used on turbines Classes 1 and 6, and proved totally unsuitable; the metal disintegrates rapidly owing to temperature, in a similar manner to the wheel blading previously described.

2. *25 per cent. Nickel Steel* (*K*).—This metal has also been used on turbines Class 1, and stands up well for a time, but becomes brittle with use. One failure has occurred, the blade breaking at the narrow part of the neck where fixed to the segment. In the case referred to failure occurred after 33,000 hours. K steel has also been used for the first row of blades on the stationary segments of the auxiliary turbines, Class 6, and one case is on record where the blades failed by breaking at the root after 15,000 hours.

3. *Five per cent. Nickel Steel* (*P*).—This material is now used exclusively for all *main* turbine stationary segment blading, and stands up very well. In some cases renewal has been necessary owing to wear, the inlet edge particularly becoming concave, and both edges very thin and easily broken. Where more than one row of stationary blades is used, as on turbines Class 2, it is the first row which suffers, but this row does not require re-blading under 20,000 hours. The second row has not so far been re-bladed, the maximum running hours being 30,678. In the auxiliary turbines, Classes 6 and 7, P steel is nearly always used in the first row, and frequently in the second.

4. *Brass* (*M.*)—Brass is sometimes used for the second row of the auxiliary turbines, Classes 6 and 7, and, under present practice, always for the third row. It stands well, the maximum hours in use so far being 30,673.

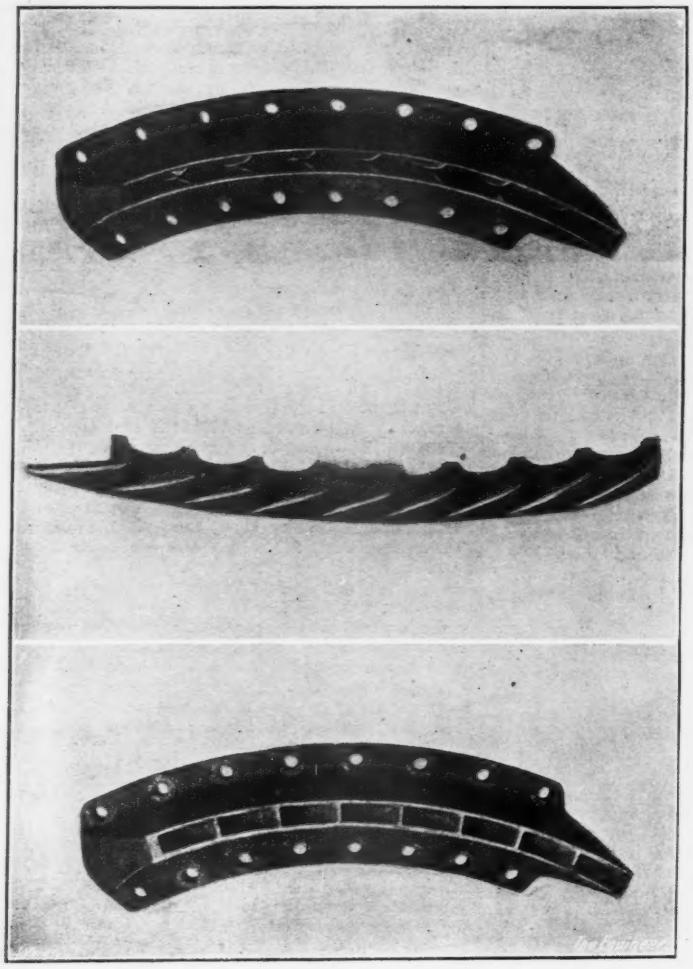
It will be seen from the above that the metals used for Curtis stationary blading behave in the same manner as when used for Curtis wheel blading.

GUIDE BLADING.

In introducing the subject of deterioration of these blades, it will be as well to commence with a description of what actually happens to the blade, and afterwards take a few typical cases, 30 per cent. to 32 per cent. nickel steel (J) is the material in general use, and, unless otherwise stated, the deterioration refers to this material. The nature of the deterioration is the same in all cases, but the results, taken over a given period, are quite inconsistent, and vary considerably with different turbines in the same station, and show a still greater difference with similar machines at different stations. The first visible indication appears in the form of a fine crack, always on the inlet side of the blade, and frequently close to the outer retaining ring, but sometimes near the centre of the blade. Before these cracks are actually visible they can be produced by a few light hammer taps. These cracks extend over the surface of the blade, cobweb fashion, until pieces become detached and pass through the succeeding stages, severely bruising and closing up the wheel blading on the inlet side, but seldom causing a strip; the amount of damage done is naturally regulated by the size of the broken piece. All blades in the guide ring are not affected at once; generally, isolated blades distributed round the ring develop these cracks, but often the defective blades appear in batches; ultimately the whole of the blades crack, and if not attended to the guide ring collapses, causing heavy fouling and serious damage to the wheels and blading.

Fig. 10 shows a portion of a guide blade diaphragm, the cracks in the blades being clearly visible; this had been in commission for 9391 hours only, on one of the compressor turbines, Class 5, and failed a few months after this photograph was taken owing to lateral movement of the diaphragm having taken place in the direction of the following wheel, which was ultimately fouled.

Fig. 11 shows a portion of the upper half of the guide ring for the eighth stage removed from No. 5 generator turbine, Rosherville, after 7801 hours. This was due to mechanical damage caused by a partial strip; the mechanical damage is, however, slight, and an examination of the ring is interesting, nearly every blade being



Figs. 6, 7, and 8

Fig. 9

* Paper read before the South African Institution of Engineers. Abridged.

* "Design and Construction of Steam Turbines." Martin. Page 231.

fractured where joining the inner and outer retaining rings. The photograph is not clear, but the light splashes near the lower ring show where fracture has taken place, and, in addition, several blades have holes right through them, more particularly at the junction between the curved portion and the straight. The portion of blade clear of the retaining rings looks quite good until smartly tapped with a hammer, when the characteristic cracks showing early deterioration are produced. The lower half of this ring, which had only run 3165 hours, was removed and carefully examined, but it was found to be quite sound.

Fig. 13 shows three loose guide blades from generator turbines, Rosherville, in various stages of deterioration. (A) (Specimen 2/15) was removed from seventh stage guide ring No. 2 set after 15,308 hours; (B) (specimen 4/15) from seventh stage No. 3 set after 18,023 hours; (C) (specimen 12/15) from twelfth stage No. 2 set after 19,887 hours. These blades are in the same condition as when in position in the guide ring, and have not been further damaged during removal. Fortunately, in the case of the guide blade rings under discussion, there is little danger when the cracks first appear, as several months elapse before pieces of guide blade break away.

first two, and 12 lb. per square inch for the third, the weight carried per blade is shown in the right-hand column.

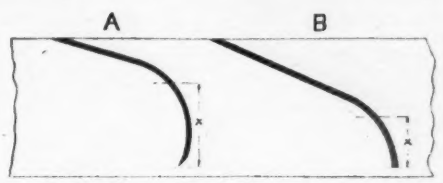
	Area of diaphragm.	Number of blades.	Pitch of blades.	Weight carried per blade.
	sq. in.		mm.	lb.
9600 K.W. turbines, Class 2	4624	148	42.0	187
12,000 K.W. turbines, Class 4	3606	76	74.6	284
10,000 H.P. compressor turbines, Class 5	2109	52	84.0	486

Fig. 14 shows the difference in the shape of the blades for a guide ring and a guide blade diaphragm. It will be noticed that the curved portion marked X is much longer in the former than in the latter construction.

With regard to the life of these blades, Table No. VI. gives the number of running hours up to the time of replacement, if such has taken place, or up to September 30th, 1916, if the original rings are still in use. All the turbines are of 9600 kilowatts (Class 2), five being in use at Rosherville and four at Vereeniging. The conditions are generally the same at each station, with the exception of the steam temperature, which is 350 deg. C. at Vereeniging, as against 320 deg. C. at Rosherville. Reference to the table shows the great disparity in the running hours between the various stages at the same station and the same stages at the two different stations.

First, it will be noticed that in no case has it been necessary to renew the first four guide rings owing to small pieces of blades broke away, and in some cases the rings were in an absolute state of collapse before being renewed.

Allowing for this difference in condition, however,



BLADE FOR GUIDE BLADE RING. BLADE FOR GUIDE BLADE DIAPHRAGM.

Fig. 14

there is no satisfactory reason to account for a difference of over 8000 hours in the life of stage 7 on sets 1 and 3. The variation in the life of the centre stages on the Rosherville and Vereeniging sets is very marked, and

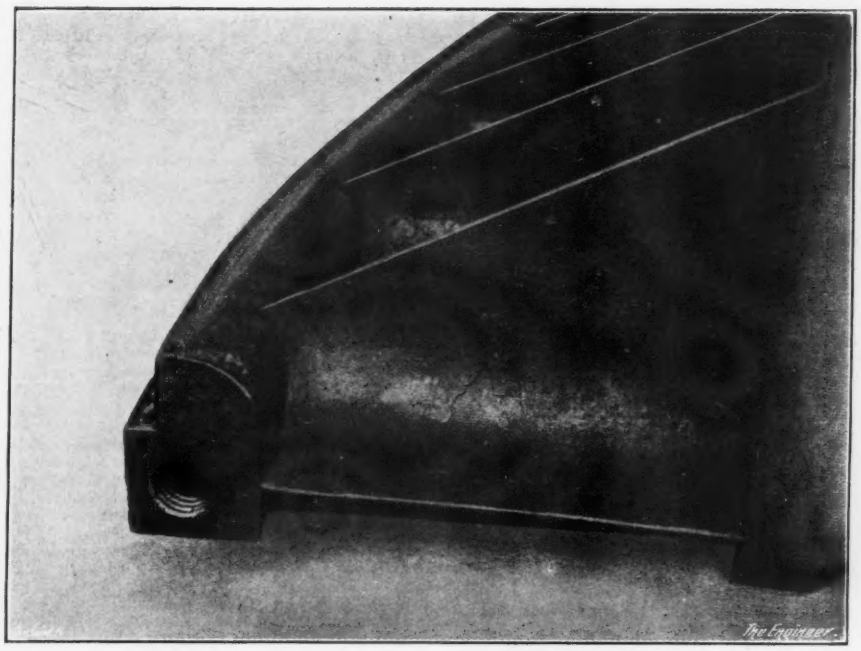
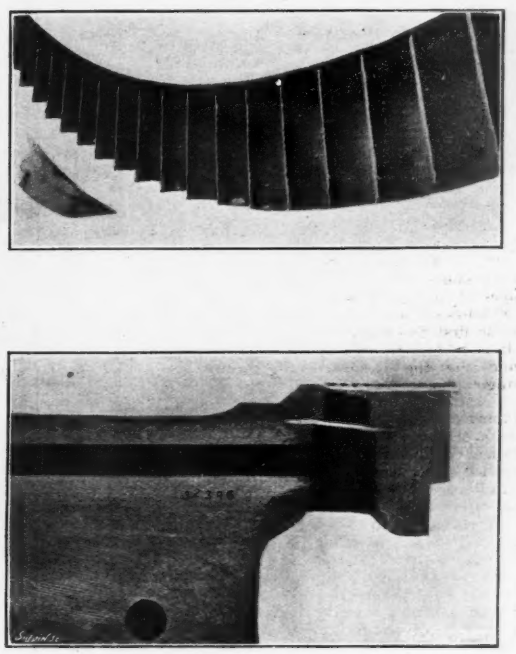


Fig. 10



Figs. 11 and 12

Examination at intervals of 3000 hours allows one to follow the condition and judge when the ring should be renewed.

In the case of the guide blade diaphragms, as fitted to Class 4 and 5 turbines, they become unsafe as soon as cracks appear, and movement of the diaphragms in the direction of the following wheel has taken place on different occasions. This tendency to displacement of the diaphragm is probably due to the circumferential pitch of the blades

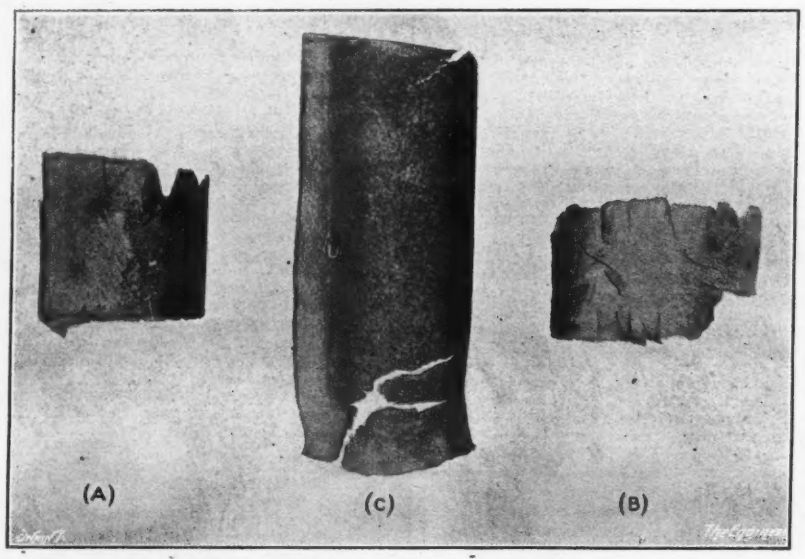


Fig. 13

in the guide blade diaphragm construction being greater than in the guide ring construction, with a consequent increase of diaphragm area per blade. The subjoined table gives the diaphragm area exposed to the difference of steam pressure between the inlet and discharge side, also the number of blades and pitch for the first set of guide blading, *i.e.*, for stage 2. Three classes of turbines are dealt with, the diameter being taken to the nearest inch. There are 12, 11 and 4 Rateau stages, in Classes 2, 4 and 5 turbines respectively, and assuming the pressure drop across each stage to be 6 lb. per square inch for the

deterioration; in one case renewal has taken place; this was, however, due to mechanical damage owing to fouling some hard material, probably a piece of nozzle vane. It will also be noticed that deterioration commences first in stage 7 on the first five sets, and that the life varies from 9900 hours on No. 1 to 18,023 on No. 3. As in the case of the wheel blading, the "life" does not represent the time the blades would actually have lasted; it simply shows that when removed the blades were defective, the degree of deterioration varying considerably. Generally speaking, no rings were renewed until before attempting to explain this it will be well to consider possible causes for this deterioration.

INFLUENCE OF MATERIAL ON DETERIORATION.

The evidence is hardly sufficient to state definitely the relative advantages of high or low percentage nickel steel, but the results obtained in No. 4 set, Rosherville, point to steel containing no nickel as being more suitable. Stages 6 to 13 on No. 4 were tested in exactly the same manner, *i.e.*, they were struck sufficiently hard with the ball of a hammer to indent the blade in several places where exposed at the horizontal joint. Cracks could only be produced on stages 7 and 12, which on analysis were found to contain 30 per cent. nickel; the other stages resisted this somewhat drastic treatment, and these blades were marked H by the makers and found to contain no nickel. When last examined there was a good deal of pitting on the convex and concave portions of these H blades, which effect is unusual with the nickel steel blades.

We are experimenting with different classes of steel;

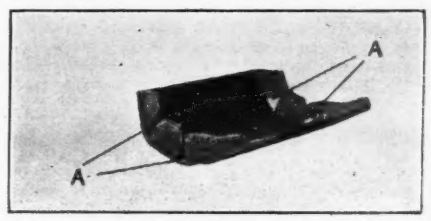


Fig. 15

Siemens-Martin, and 5 per cent. and 3 per cent. nickel steel being at present in use, cast into the retaining rings in a similar manner to that adopted by the makers. The test is of far too short a duration to form an opinion as to the respective merits of these various steels, and the time required is one of the drawbacks to these experiments, as, even when the turbine is run at a very high load factor, two and a-half to three years must elapse before we can say that a definite improvement has been made, unless, of course, the steel on trial gives much worse results than that at present in general use.

On the Class 4 turbines H steel, containing no nickel, has been supplied for some stages, and has so far shown no deterioration, while other stages, containing 30 per cent. nickel (J steel) in the same machine have shown marked deterioration, but these will be referred to later.

In the case of the guide ring renewed on No. 4 set, Vereeniging (stage 10), some of the blades were badly

cracked, and others appeared to be in perfect condition; one of each was analysed, and both were found to be 30 per cent. nickel steel, the inference being that the presence of a high percentage of nickel does not necessarily cause the blades to crack.

A non-ferrous material might be tried with good results. The cost would be a good deal higher than if steel were used, but that would not matter much if the life were considerably increased. Casting iron round blades made from Monel metal sheet has been tried, but the heat of the molten metal appears to take the nature out of the copper-nickel alloy, rendering it short, so that it cracks and breaks on bending.

Mechanical Stresses Imposed on the Blades by Expansion and Permanent Growth of the Retaining Rings and Diaphragms and by Sudden Changes of Temperature in the Blades.

We have ample evidence of the exceedingly heavy stress imposed on the blades from this cause, particularly at the high-temperature end of the turbine.

When the machines were first erected the guide rings were fitted to a groove in the casing, and secured thereby by means of screws; the C.I. diaphragm, of dished formation, is grooved round the periphery and fitted snug to the inner retaining ring of the guide ring, there being a corresponding tongue fitting the groove of the diaphragm to prevent lateral movement. The convex side of the diaphragm is towards the high-pressure end of the machine, and is designed to resist the difference of pressure between the inlet and discharge side of the guide rings. It may have been assumed by the makers that this dishing would relieve the blades of excessive stress by deformation of the casting, and the latter effect actually occurs, as it is found that the clearance between the diaphragm boss and the preceding wheel gradually diminishes. It, however, does not relieve the blades sufficiently to prevent severe buckling of the first two rings.

In addition to the buckling of the blades, they are badly cracked, due, doubtless, to the enormous stress imposed. This particular ring was in commission for 39,000 hours, and is the first one renewed on the early stages of the machine owing to cracked blades. On the 9600-kilowatt sets these cracks have not yet appeared on the first five stages.

It is seldom the blades are buckled beyond the third guide ring, the expansion of the guide rings and diaphragms being naturally less as the temperature decreases, until at the exhaust end it is comparatively low, seldom exceeding 50 deg. Cent. If we assume heavy pressure on the blades to be the cause of the cracking, it seems strange that where the pressure is heaviest the blades are least affected. It may be a contributory cause, but in any case it is obviously better to relieve the blades of this stress as far as possible, and this has been accomplished in the case of the guide rings by machining a 3 mm. clearance between the guide ring and diaphragm and resting the diaphragm on two short fitting strips on the lower half. A few copper pins are fitted on the upper half of the guide ring, with about 0.5 mm. clearance between the pins and diaphragms, so that the latter cannot rise too much and foul the shaft gland. It is found that after a time these pins are crushed by the diaphragm, and they are eased periodically.

In the case of the guide blade diaphragms these are suspended on lugs at each side of the turbine casing, 3 mm. clearance being left all round the casing groove, so that the diaphgram is free to move when fitted, but gradually tightens sideways in the groove as the growth of metal takes place.

In sets 1 and 2, Rosherville, cracked blades are found in the eighth stage after 8700 and 9700 hours. Also in the eighth stage of No. 5 set, Rosherville, after 7801 hours. These three rings were eased when first fitted, and have never been subjected to heavy pressure. It therefore seems clear that the metal deteriorates irrespective of the compression to which the blades are subjected.

In the case of the guide blade diaphragms on turbines, Classes 4 and 5, which were fitted to relieve blade stresses, 1 mm. clearance was left round the circumference by the erectors. This was absorbed during the first year of running, and, in addition, in some cases, very heavy distortion has taken place.

Fig. 12 shows the guide blade diaphragm for the second stage on one of the 12,000-kilowatt sets installed at Brakpan in 1915, and the photograph was taken after 8822 running hours (14 months). The rim of the diaphragm portion should be flush with the top side of the outer retaining ring, but has moved $^3/_{16}$in. toward the following stage, shown by the dotted line. In addition, practically every blade is cracked, this being the first instance which has occurred at such an early stage in the machine after such a short life; the material is 30 per cent. nickel steel, 2 mm. thick. In this case the clearance was most likely very soon taken up, and the heavy pressure doubtless had much to do with the cracking and was mainly responsible for the distortion.

Finally, we have cases on record where long life has been attained without the rings being eased at all. On one of the 3000-kilowatt sets installed at Brakpan some of the blading was renewed after 46,890 hours (stages 2, 6, 7), and on the adjoining set the blading was eased after over 40,000 hours, and is still in commission and in good condition after 59,000 hours, with the exception of the guide ring for stage 2, the blades of which are now cracking. In both machines the blades are of J steel. The steam temperature at the stop valve has been somewhat lower on these sets, being about 290 deg. Cent., as against 320 deg. Cent. to 350 deg. Cent. on the sets previously dealt with. This difference in life is most difficult to account for. Some makers use steel castings for turbine diaphragms, and this material possesses an advantage over cast iron in that it is not, as far as the author is aware, subject to permanent growth to the same extent as the latter material.

With regard to the sudden expansion of the blades themselves when starting up a set from a cold state, the blades are thin and will temporarily attain a higher temperature than the retaining rings; they will be subjected to compression stresses on this account, although 30 per cent. nickel steel probably has a very low coefficient of expansion; 36 per cent. nickel steel (invar), used for instrument work, has no coefficient of expansion.

In this connection the number of starts over an extended period have been examined on the various 9600-kilowatt sets, but this does not seem to have any bearing on the life of the blades, and it is probable that these stresses are not so serious as others which the blades are called upon to withstand.

It having been decided to cast these guide blade rings locally, their manufacture presented some difficulty at first, and previous to the work being put in hand some of the old guide rings were re-bladed as an emergency measure. Ordinary steel plate, 2 and 3 mm. thick, was used, cut to shape and bent round a former. The blades were then flanged and riveted between the retaining rings, a fairly neat job being made. Fig. 15 shows the blade ready for fixing. The blades were quite sound when last examined, but had only been in commission for 2839 hours. It will be interesting to see whether this method of building up the rings will increase the life of the blades. There may be some advantage in the flanging, a little more elasticity, perhaps, and, further, the blades are not subjected to the intense heat which is unavoidable when the molten iron is cast round them.

It is significant that the turbine in which these re-bladed rings are fitted is less efficient than the others of similar type. This may be due to the rivet heads and flanged portion of the blades, which project into the steam passage and obstruct the steam flow.

Other Stresses, Vibration, Impurities in the Steam, &c.

If we assume the drop in pressure across each diaphragm to be 6 lb. per square inch, and the diameter of the diaphragm to be 60in., the guide blades have to withstand a lateral force of 8.4 tons, which, divided between the blades, may not be excessive. In addition, however well the machine is balanced, a certain amount of vibration will take place, due to the rotation of the parts, and also due to the passage of steam through the blading. This vibration, acting on the guide blades, while under stress from the diaphragm pressure, and perhaps at a critical temperature, may cause cracks to develop and ultimately break down the material. Another factor which may influence deterioration and account for the difference in life at various stations is impurities carried over from the boilers with the steam. For instance, on the 3000-kilowatt sets at Brakpan, where exceptionally long life has been attained, the boilers are supplying steam to reciprocating compressors, and oil used for lubricating the steam cylinders has found its way into the boilers, and from these to the turbines. It occurs here as a greasy deposit on the guide blades, which may have acted as a protective covering. The feed water make-up at this station was at one time strongly alkaline, being quite different from that at Rosherville or Simmer Pan, while at Vereeniging river water is used, which is comparatively soft.

Two final cases are given, which are interesting on account of the rapidity with which deterioration takes place, and also because the machines are of later design than those previously described. The first of these is one of the 12,000-kilowatt generator turbines installed at Brakpan, containing 11 guide blade diaphragms, the blades in the first seven being 2 mm. thick, of high percentage nickel steel J; of these the 1st, 6th and 7th contained blades so badly cracked after 8822 hours as to be unsafe, while in the 5th the blades were just commencing to crack; in diaphragms 2, 3 and 4 the blades were quite sound; in the remaining four stages, beyond the 7th stage, the blades are of steel containing no nickel (H) and are in good condition; in three of these the blades are 3 mm. thick, and in the fourth and last 4 mm. thick. The first five stages on this set have been subjected to heavy pressure, so much so that displacement of the diaphragms has occurred, as shown in Fig. 12, previously described. It would appear from the above that the steel H, 3 mm. thick, will give better results than the 2 mm. J steel, although it is strange that in diaphragms 2, 3 and 4 the latter material shows no cracks; one can only conclude that there must be some difference in manufacture of the plates from which the blades are made, as the rough analysis shows the material to be similar, and the conditions are the same as on the diaphragms at either side.

The other case is on the three large compressor turbines of 10,000 horse-power installed at Rosherville. There are five guide blade diaphragms in these sets, the first two containing H steel blades without nickel, 5 mm. thick on the inlet side, tapering to 2 mm. on the outlet side. These blades show no cracks after 11,000 hours. Diaphragms 3, 4 and 5 contain blades 2½ mm. thick, of uniform section, and on two sets diaphragm 3 has nickel steel (J) blades, which have both cracked badly after 10,000 and 11,000 hours respectively. On the third set blades containing no nickel (H) are used, and at present are quite sound after 6000 hours. On the fourth diaphragm (J) steel has been used for compressors 8 and 9, and in both cases the blades have cracked after 11,000 and 6000 hours respectively; while on compressor 7 H steel is used and is in good condition after 10,000 hours. J steel is used throughout for diaphragm 5, and when examined the blades were cracked in one case only.

The following table shows the arrangement of blades and condition when examined after the number of running hours specified. H signifies steel containing no nickel, and J 30 per cent. nickel steel:—

10,000 *Horse-power Compressor Turbines.*

Diaphragm number.	No. 7. 10,362 hours.	No. 8. 11,543 hours.	No. 9. 5994 hours.
1	H, steel good	H, steel good	H, steel good
2	Do.	Do.	Do.
3	J, cracked	J, badly cracked	H, good
4	H, good	Do.	J, slightly cracked
5	J, good	J, cracked	H, good

The above results point to H steel being a much more suitable metal for guide blading than J steel. No. 7 compressor has been opened up quite recently (since the above table was drawn up), and the guide blades have been hammer-tested severely. In the third diaphragm cracks in the blades are clearly visible before hammering, and with a few smart blows the cracks extend over the surface and pieces can be knocked out. The H steel blades, containing no nickel, used in diaphragm 4, were treated in the same manner, but no cracks were produced, the metal being quite sound. In diaphragm 5 no cracks were visible until the blades were struck a few times, when the cracks appeared, showing the metal to be in the early stages of deterioration. The guide blading was in commission for just over 13,000 hours when this examination took place.

Conclusions.

In summarising the behaviour of the materials used in blading these turbines, it will be seen that there is no difficulty in choosing a material for moving blades which can be depended on to give fairly satisfactory results in particular stages. Five per cent. nickel steel, brass and aluminium bronze in suitable stages will have a life of 40,000 hours, and perhaps 50,000, or more, which, if the turbines are run continuously, means five or six years. It is probable that in the majority of power stations the running hours would be much less, and the number of years the blades would last will be correspondingly increased. One has to decide what constitutes a satisfactory life, and if we assume the turbine will be in use for 15 or 20 years, the ideal blade material is one which will do its work efficiently for this period. If long life can only be achieved by the use of expensive alloys, the cost of such material would have to be compared with the saving in maintenance which would result by its use.

With regard to the life of turbine plant, one has to consider the probability of future improvements, which might increase the efficiency of turbines to such an extent that it would pay to scrap existing plants and install new ones.

One has to admit, however, that a very considerable advance in efficiency would have to be made to justify this course, and the uncertainty of a sufficient improvement is a further argument for better blading material.

A saving of 1 per cent. in coal consumption on a 10,000-kilowatt set supplying 6,000,000 units per month may represent about £400 per annum.

With regard to inlet nozzles, it is clear that no reasonable expense should be spared in making these absolutely reliable; nozzles with thin cast iron vanes should be abolished, but if cast iron is used the design should be such that there is no possibility of pieces becoming detached.

The guide blading in use on these turbines is clearly unsatisfactory, and the reader may wonder why this state of affairs has not been remedied long ago. The user is, however, largely in the hands of the turbine builder, and, further, if a mistake has been made in design or material in the original installation, three years or more must often elapse before this is discovered, and an equivalent time is taken to prove the success or otherwise of any alteration. Incidentally, thousands of pounds are spent by the user in large installations in renewing defective blading and making good damage caused by broken pieces, collapsed rings, &c. This maintenance should be unnecessary, and for this reason the defects have been given in considerable detail.

While the author feels that mild steel is preferable to the high percentage nickel steel in use, it must be admitted that the latter has given good results in many cases. On the fourth diaphragm J steel has been used for the 10,000 horse-power compressors 8 and 9, and in both cases the blades cracked, while on compressor 7 H steel and is in good condition.

High percentage nickel steel has been more extensively used and for a much longer period than non-nickel steel. The latter material is in use on No. 4 generator turbine, Rosherville, and in this case considerable pitting has occurred. The evidence obtained on the 10,000 horse-power compressor turbine, Rosherville (No. 7), is, however, very much in favour of mild steel, and there seems little doubt that it will prove the better material. The possible causes of deterioration are not conclusive; they may all be contributory to the general failure, and the inconsistency of results, particularly at different stations, makes the whole subject very puzzling. One is inclined to blame 30 per cent. nickel steel because so much of it is in use and fails, and it may be that mild steel will also prove unsatisfactory through cracking or pitting.

Blades made from brass sheet and carefully fitted to retaining rings have been used for small turbines by some manufacturers, and various methods of attaching blades could be devised. The cast-in method used on the turbines described in this paper is, however, very simple and requires a minimum amount of machining and fitting, so that it would be preferable to retain this design if satisfactory results can be obtained.

The author believes that the position can be much improved by the use of thicker blades of mild or low percentage nickel steel, say, $^3/_{16}$in., or ¼in. tapered, perhaps, on the outlet side to ⅛in. Unfortunately an alteration of this kind on a ring designed for 2 mm. blades reduces the area for steam passage somewhat. To obtain the same port area the radial length of the guide blade would have to be greater, necessitating a longer moving blade. The following alterations have been made, which may result in a considerable improvement in the life of the guide blades.

In the case of the guide blade diaphragms for the 10,000 horse-power compressor turbines, in addition to substituting B, C and C1 steel for J steel, the blades have been increased in thickness from 2.25 mm. to 3 mm. in three diaphragms on one turbine without affecting the efficiency or output.

On the 12,000-kilowatt generator turbines at Simmer Pan and Brakpan six stiffening blades of mild steel, $^3/_{16}$in. thick, have been cast in each half; these are distributed equally round the diaphragms and take the place of the J steel blades, 2 mm. thick, originally used. The remaining blades are 2 mm. thick, B, C and C1 steels being used in the various diaphragms.

On the same class of turbine another experiment is in hand; cast iron stiffening blocks are being cast between adjacent guide blades on the horizontal and

vertical diameters of the diaphragm. This blocks up four ports in the complete ring, and should stiffen up the diaphragm very considerably. In addition, the material has been changed from high percentage nickel steel to B and C steel.

The guide blade diaphragms on which the last two experiments are being tried are not yet in commission, so that the effect on efficiency is at present unknown.

The author cannot say whether similar trouble is prevalent on turbines made by other firms, and any discussion which this paper may promote will be valuable in throwing light on the best design and material for turbine blading. It is hardly to be expected that manufacturers will advertise defects in their machines, but users need have no scruples in this respect.

ADVANCES IN WAGES.

AN award has been issued by the Committee on Production giving a further advance of wages to all grades of workmen employed by members of the Engineering Employers' Federation.

The award is given in pursuance of an agreement between the federation and forty-six trade unions connected with the engineering and foundry trades, under the terms of which the Committee on Production may be called upon at intervals of four months—*i.e.*, February, June, and October—to consider what alteration in wages is warranted by the abnormal conditions due to the war. The Committee has also issued similar awards covering the shipbuilding industry, the ship-repairing trade on the Mersey, and the iron-founding trades of Scotland.

The previous awards of the Committee gave the men an advance last April of 5s. per week, and thereby established a general advance over pre-war rates of 12s. per week. The awards now issued give a further advance of 3s. per week, making the aggregate increase on pre-war rates 15s. per week. An advance of 1s. 6d. per week is given to boys and youths.

THE RATHO RAILWAY ACCIDENT.

THE first fatal accident to a passenger train this year and, at the time of writing, the only one, occurred on January 3rd, at the Queensferry Junction, on the Edinburgh-Glasgow main line of the North British Railway Company, under circumstances which were related in our issue of January 19th. Owing, however, to both the drivers concerned in the accident being seriously injured the report of Colonel Pringle, who inquired into it, has only just been issued.

To appreciate the cause of the accident it should be understood that at this place there is a double line junction with a branch from Dalmeny. This latter is a single line, and the two connections which form the double junction come together as a single line junction at a point 138 yards west of the signal box. Passenger trains on the branch are reversed at the junction by the train running on to the down connections, which, from the single line junction, is a movement in the facing direction. The engine, after being detached from the empty coaches, is run round through the cross-over road on the main line, and is then set back in the wrong direction along the up connection, and, having got on to the single line, is set back on to the coaches. There is no trap point at the fouling point of the down connection nor any signal, but this fact is well known to those drivers which use the branch regularly. The method of working, further, has been in force for a long number of years.

In the report the evidence of only the two principal witnesses is given. These are driver Ramsay, of the light engine, and Philp, the signalman. The former related that up to January 1st he had never worked any passenger trains from Dalmeny to Queensferry Junction. On that date the signalman called him past the home signal by a white light and he came to a stand at the signal-box. After the fireman had handed over the tablet that man uncoupled the engine and driver Ramsay ran round the train. On the 2nd he again received a white light, but on reaching the box he was shown a red light, and after standing about ten minutes, received a white light and told to proceed. On the 3rd he received no instructions on getting to the box, so, after the engine had been detached, he started ahead, and just as he got on to the down main line his engine met the 4.18 express from Edinburgh to Glasgow, which was approaching with all signals in its favour. As a result of the collision twelve passengers were killed and forty-four seriously injured. All four enginemen were also badly hurt, the driver of the express so much so that he has been unable to give evidence. Colonel Pringle does not, however, consider that he was in the least to blame.

The conclusion of the Board of Trade Inspector is that this is an unfortunate illustration of the danger of taking things for granted, and he blames both the signalman and the driver of the light engine. The origin of the accident is, however, the thinks, to be traced to the irregular way in which the train was dealt with. As a result of a collision at this place in December, 1911, some shunting signals were provided, and, Colonel Pringle remarks that, to his mind it is inexplicable that, despite their knowledge of the present facts the local traffic representatives continued the daily practice of rounding the empty carriage train in the manner described without recognising the need for similar protection in the case of the down loop connection. It appears also that the district traffic inspector used to be a signalman in one of the adjacent boxes, and on this point the Board of Trade Inspector says that he cannot help thinking that the policy of such appointments is open to criticism. The circumstances show that, as inspectors, they are unlikely to recognise as dangerous or irregular methods of working which, as signalmen, they have long approved and adopted, and they cannot therefore be expected to draw attention to or check such practices. The report concludes with a recommendation to all railway companies that the methods in vogue at junctions and other railway centres where passenger or goods services terminate, for disposing of or rounding vehicles, should be periodically examined and reported on by competent officers, in order that irregular methods of working or insufficient protection in the way of signals and trap points may be noted and rectified.

DEALINGS IN PIG IRON.

WITH reference to the Order made by the Minister of Munitions on the 7th July, 1916, applying Regulation 30A of the Defence of the Realm Regulations to war material consisting of certain classes and descriptions of metallurgical metal, coke, pig iron and steel, and to the general permit for dealing in such war material issued by the Minister of Munitions on the 1st November, 1916, the Minister of Munitions gives notice, under date July 17th—

(1) That the said general permit is modified by the insertion in the schedule thereto of the following prices for the articles hereunder specified, in addition to, or, where such articles are already specified in such schedule, in substitution for the prices contained in such schedule.

MAXIMUM PRICES FOR PIG IRON ABOVE REFERRED TO.

	Per ton net f.o.t. Makers' works. £ s. d.
Hematite Pig Iron—Malleable.	
Refined Cupola cast	8 0 0
Refined Cupola cast to guaranteed analysis	8 5 0
Cast direct from Blast-furnaces.	
Small pig iron—all grades	7 10 0
Medium pig iron white to grey mottled	7 5 0
Medium pig iron—all other qualities	6 17 6
Large pig iron—all grades	6 17 6

All the above prices include agent's commission or merchant's profit, which is not to exceed 5s. per ton.

Applications for licences to sell special grades of extra quality at special prices will be separately considered by the Director of Steel Production.

	Per ton net f.o.t. Makers' works. £ s. d.
Cleveland Pig Iron.	
Basic	4 17 6
South Staffordshire, Shropshire, and Worcestershire Pig Iron.	
Basic	4 17 6

All the above additions to the schedule of the general permit shall take effect from the date of this notice, and none of such additions shall be deemed to prejudice or interfere with the carrying out of any contract in writing for sale or purchase of the above-mentioned war material entered into prior to such date at prices lawful at the date of such contract.

	Substituted price. Per ton net f.o.t. Makers' works. £ s. d.
Cleveland Pig Iron.	
No 1	4 16 6
Other grades	4 12 6
South Staffordshire, Shropshire, and Worcestershire Pig Iron.	
"Part-mine" forge	5 0 0
"Part-mine" foundry	5 2 6

The above substituted prices shall take effect from the 2nd April, 1917.

(2) That in further modification of the said general permit in all districts an extra charge of 1s. per ton may be charged over the fixed maximum price for basic pig iron cast in chills.

COAL AND TIN MINING IN BRITISH MALAYA.

LAST year was a profitable one for tin miners in the Federated Malay States. For although the output was 2896 tons less than in 1915, higher prices ruled throughout the year, and the total value of the 43,870 tons exported amounted to £7,526,566, as compared with £7,164,968 for 46,766 tons in 1915. The average price on the local market was equivalent to £171 11s. 2.1d. in 1916, as compared with £153 4s. 3.1d. in 1915; on the London market the lowest price was £161 10s. per ton, and the highest £205, the average being £182 3s. 5d. per ton.

In his yearly review of mining in the Federated Malay States, the Senior Warden of Mines—Mr. W. Eyre Kenny, M. Inst. C.E.—gives the following comparative table of output and value of tin in the four States :—

	1915. Tons.	1915. £	1916. Tons.	1916. £
Perak	27,776	4,255,603	27,242	4,075,379
Selangor	13,938	2,135,236	12,241	2,099,072
Negri Sembilan	1,244	189,699	907	155,887
Pahang	3,808	584,430	3,480	596,228
	46,766	7,164,968	43,870	7,526,566

Shipping and other charges, however, showed an increase as compared with the 1915 figures.

There were no labour troubles or disturbances during the year, though shortage and increased cost of labour were complained of. These were said to be due to mining labour taking to the cultivation of rubber. The total labour force employed on mining at the end of the year was 139,143—all of whom, with the exception of 1087 men, were employed on tin mining—as compared with 164,457 in 1915, and 171,689 in 1914. Of the miners, 132,053 were Chinese, 4921 Indians, and 1904 Malays. There were 197 Europeans employed in supervision at the mines.

In the previous year a substantial increase had been shown in the use of modern machinery in the mines, and in 1916 there was a further increase of 1877 horse-power.

The supply of coal was a source of anxiety until the Malayan Collieries got into full work. Work was, however, carried on at the Malayan Collieries throughout the year. The output was 101,846 tons.

In the North Mine the main haulage way is down 1300ft. on the slope, and in the South Mine 1200ft. The power-house capacity is to be increased by 600 kilowatts; air compressors, compressed air operating plant, ventilating plant and other machines are under order.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Iron Trade Activity.

THE tone is very brisk in the finished branches of the market. Offers of business are much larger than producers are in a position to accept. There is a continuous demand for bar iron, particularly for the higher grades. The new shipbuilding programme has tended to quicken activity. The books of some firms are loaded till the end of the year. In these circumstances, the only new sales effected are for urgent Government work. Makers who are desired to undertake specifications for mixed assortments for home supplies, not associated with naval and military requirements, cannot entertain them. The marked bar makers report that if they chose to accept contracts from merchants, they could determine for a period of from one to two years. However, they prefer to keep their bargains to a reasonable period, as it is impossible to enlarge works with a limited labour supply. For unmarked bar iron the demand seems to expand, and makers state in the case of some prices they are on the heels of best iron producers. The latter have a heavy list of orders from the Government for rolling stock firms. Shipping merchants experience disappointment, and notify that they may close their establishments until they have a reasonable hope of placing orders for rolled iron and steel.

Finished Iron Prices and Prospects.

There is no change in controlled prices. Bar makers consider they have a good claim to a relaxation of the present restrictions, inasmuch as cost of production has increased—by not less than 5s. per ton, some of them say—since the present scale was fixed a year ago. It is not unlikely that the new quarter upon which the trade has now entered will see a definite movement for a revision of the £15 10s., less 2½ per cent., for marked bars, and £13 15s. net for merchant bars, f.o.t. at makers' works. Ironmasters say the cost of production has been appreciably increased since the restrictions were placed on prices, and it is not unlikely that this view will be presented to the Ministry; but it does not appear that any definite step has been taken in that direction. In any case, the Staffordshire trade will not move independently. Bearing in mind the tension of demand, it says something for the moderation of the trade that the upward movement of prices in the uncontrolled departments has been so gradual during the quarter which expired with June 30th. An advance during that time in small rounds of 5s. is certainly not more than might have been expected, having regard to the pressure of all classes of small iron. The price is now £16 15s. and upwards for three-eighths rounds. Gas strip has firmed up to about £15 10s., and in the present state of supply and demand makers are in no anxiety as to the disposal of their output. American steel rods in the past quarter have gone materially higher, and mild steel wire has been advanced £5 per ton. Repeated offers were submitted to-day—Thursday—for small rounds and like material, which the makers would not consider, even at very high prices, solely because they could not give deliveries when wanted. Hoops and rods were inquired for by Government contractors in excess of acceptances. Nut and bolt bars sell at from £14 5s. to £14 11s. 3d. delivered in the district. What business is passing in puddled iron is on the basis of £12 5s. Puddled billets command £13 5s. to £13 10s. The sheet trade shows further shrinkage. Black sheets are still quoted at £19 10s., and galvanised corrugated sheets at £28 10s. for 24-gauge. The extra of £1 for painting plain sheets has been raised to £1 5s. At a meeting of the Staffordshire Tinned Sheet Association, it was reported that business on home account was very active. The prevailing prices were re-affirmed as follows:—Best charcoal, 52s. per cwt.; charcoal, 50s.; coke, unassorted, 46s. Tin-plates remain at 46s. to 60s. per box. This branch is very busy.

Pig Iron Trade.

More basic iron is being called for, but smelters are very fully occupied with forge and foundry sorts, and it is only here and there that any curb is applied to would-be buyers. Some furnace owners have pledged the greater part of their production for the rest of the year. A couple of furnaces in the Dudley district which have been standing for some time will be started as soon as possible upon the production of basic, and negotiations are proceeding for the erection of a new and up-to-date furnace, capable of producing 4000 tons a week, upon the same ground. South Staffordshire smelters are being pressed for foundry iron for fulfilment of Government contracts. Elsewhere current demand seems to run very strongly on forge qualities. A heavy tonnage of Derbyshire forge is going into consumption. A great deal of the present activity in pig iron is attributable to tactical considerations on the part of consumers. They know that in order to obtain anything like adequate deliveries they must order on a large scale; the timid buyer receives very little encouragement from most of the big houses. Makers outside South Staffordshire still attach to contracts the condition that any increase in the maxima shall accrue. There is no longer any expectation, however, that the application for a revision made on behalf of the Derbyshire and Northamptonshire trade will produce any result. South Staffordshire makers have had no difficulty in realising the full 5s. put on to their maxima. Demand is so active that it is less a question of price than of supply, and no doubt consumers would pay more for Derbyshire and Northamptonshire iron if they could expedite deliveries thereby. A large amount of Staffordshire high-grade iron is being called for. All-mine forge remains at 115s., all-mine foundry at 120s., warm air forge at 145s., warm air foundry at 155s., special quality (Lord Dudley's cylinder) at 167s. 6d., and cold blast at 182s. 6d. Other prices are :—Northamptonshire, No. 4 forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry, 94s.; basic, 97s. 6d.; Derbyshire, No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; No. 2 foundry, 94s. 6d.; No. 1 foundry, 96s. 6d.; basic, 97s. 6d.

Steel.

There is no relief in the matter of steel, requirements being greatly in excess of the available supply. America is sending little except wire rods, which make £29 to £30 at Liverpool. A few hollow blooms are on offer at an extravagant price. Steel strip is scarce, and prices show rather wide disparity. Hoops are unchanged at £18 and upwards.

The Trade Future.

Some suggestive remarks on the trade future have fallen this week from Sir E. Parkes, who is generally regarded as the leading commercial member for Birmingham. Sir Edward said that on the question of manufacturing depended our greatness, and he trusted that, through the co-ordination of all parts of the Empire, and the co-operation of the English-speaking nations of the world, there would in the future be a new development of commerce. Before the war goods were sent from Germany and other parts of the Continent which contained from 50 per cent. to 80 per cent., and perhaps more, of foreign work. Those goods were finished here, and then sent away as British-made articles. That must in future be stopped. Nothing had been done at present with regard to our fiscal arrangements with other countries, but one thing we were sure of was that we should not again cultivate commercial arrangements with Germany. It behoved employers and employed to work together for the good of the country after the war, so that our commercial prosperity might be maintained and increased.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

So far as the local market here is concerned, there is very little change; unless it be an increase in the dulness which some people attribute to holidays, some to the warm weather, and some—a small minority—to a slackening of actual orders. This latter can scarcely be the case so far as Government work is concerned. There are many people who believe that the rush for goods of all sorts after the war will lead to a continuation of high prices; and one meets with this view more frequently now than when prices were much more moderate. There are, however, two ways of looking at this question: viz., whether the demand for goods will keep up prices, or whether the high prices will choke off the demand for goods. There are, again, rumours that, undeterred by the British experiments in the way of controlling values, the American Government means to deal with steel and metal prices on the other side. In our own case the Government can use all the steel which can be produced; but this is not the case in America, and consequently the position is very difficult. If the American Government commandeers 30 per cent. or 40 per cent. of the steel production at a price, what is to be done with the remaining 60 to 70 per cent.? Will the industrial world absorb it at present rates? And what will be the effect on the wages question? These are matters which may lead to much market disturbance in the near future.

Foundry Iron.

Although no Cleveland foundry iron is yet offered in any quantity on the Manchester market, as might seem possible, the tone on the local market is dull, and, if anything, a little weak here, and the demand has certainly become less insistent than it was. At present this lesser inquiry is rather welcomed by sellers, who have for some time been inclined to avoid orders rather than to seek for them; and, of course, there is no corresponding weakening of price for the moment. Nevertheless, it is a question of how long such a slackening of demand will last; and it is also interesting to discover the cause. If this cause be merely warm weather or holidays, as some people say, then there is no occasion to anticipate a change in prices; but, if it means that the Lancashire foundries are getting short of work, the thing takes on a very different aspect. There are many who say that costs are so high that any reduction in prices is unthinkable; but, in my experience, costs have very little to do with prices in the pig iron trade, and demand almost everything to do with them. It is early yet to come to any definite conclusion regarding this matter, but it is well to consider the subject and be prepared, in case further evidence comes along. It must be remembered that at present the market here is supplied practically by two makes only, out of the six or seven which in normal times are sold here; and it is possible, if general weakness in the foundry trade should set in from other parts of the country, that some of these four or five makes will be offered again in Manchester. Derbyshire No. 3 iron was quoted as usual at 98s. 8d. per ton delivered and including the orthodox commission of 1¼ per cent., and Staffordshire at 102s. 6d. In Scotch iron a small business was done at 128s. delivered, plus a merchant's commission.

Semi-steel.

There are still no offers of semi-steel here, or of wire rods, shell discards, &c. It is said that in other centres shell discard bar steel is selling at £16 per ton, which shows up the artificiality of all our steel prices. Importing firms are not attempting to do anything in American steel or iron.

Scrap.

The position in heavy wrought scrap is the same, and business is still held up. There must, of course, be some heavy scrap reaching dealers' yards, but they say nothing about it, and meanwhile consumers are inquiring more persistently for the material. It seems unlikely that any application for a raising of the official price will be successful immediately, and more probable that nothing of this sort will be done until September; and hence the question to be considered is whether by some mutual understanding between consumers and holders a *modus vivendi* may be found. I believe there is no limit put on scrap under ¼in. thick, so that this may be legally invoiced at £5 5s., being worth, perhaps, £3 5s. or £3 10s. Heavy wrought scrap is worth at least £6 10s., and is limited to £5 5s. or £5 15s. I need scarcely say any more on this subject. In steel scrap some business has been done at £5 5s. on trucks, plus 2½ per cent., but not very much. The demand seems poor at the moment, but with the present enormous consumption of steel it should soon revive again. A curious thing is the very sharp demand for heavy steel turnings, and here again the limit put upon them of 50s. on trucks is hindering business. I do not think that any good turnings are being sold at 50s., and South Wales consumers openly offer 70s. on them. The man who loyally tries to carry out the regulations imposed on the trade, is at a great disadvantage compared with those who ignore regulations and take risks. The feeling in foundry scrap is decidedly easier, and very little selling is reported. Here, apparently, the position as regards price is not so strong as in the case of pig iron, and dealers were offering some concession upon the quotations of last week. For the best textile broken castings 115s. was being asked then, but they could certainly be bought this week at 112s. 6d., perhaps at a little less. Common cast scrap could be had at about 102s. 6d. Cast iron borings are still said to be scarce.

Metals.

There is no change, ostensibly, in copper or in spelter; but what is happening or going to happen in America is a mystery. English tin is quoted here at £244. There is no quotation for lead.

The Control of Cotton Supplies.

Much surprise on the part of Lancashire cotton spinners has been caused at the decision of the Cotton Control Board not to recommend an immediate curtailment of production by the manufacturers. It was generally anticipated that the Board, in order to prevent a general stoppage of the mills due to shortage of material, would take some drastic step to curtail consumption by the adoption of short-time working. However, after carefully considering the position as regards both the actual supplies of raw cotton in the country and those in prospect, the Board has decided to enforce no restrictions "for the present." Obviously, then, unless the Board has been misinformed, either the supply of raw material is not so low as it was believed to be, or Sir Albert Stanley has been able to give some satisfactory information to the Board with regard to shipping prospects. Nevertheless, it is certain that the supplies of cotton are at present very unequally divided amongst the owners of the 58,000,000 spindles in Lancashire and the adjoining cotton manufacturing districts. While the manufacturers in some parts have ample supplies, and are working full time, in others the stocks are said to be very dangerously low, and the millowners are alarmed at the prospects of obtaining fresh supplies to keep their machinery running. For instance, it is reported that in Bolton, where the spinning is chiefly in fine counts, there are many mills closed, while in Oldham, where the coarser counts are spun, the mills are said to be all running full time. In the meantime the Board has decided not to alter its policy with regard to the issue of licences to purchase cotton. These have still to be obtained for not more than one week's supply of spot cotton at a time by spinners who have less than two weeks' supply in stock. Although many of the mills are already being run at a loss, the operatives are agitating for a further advance in wages to cover the increased cost of living.

The Recent Explosion at Ashton-under-Lyne.

The coroner's inquiry into the cause of the explosion which occurred recently at a chemical works in the above town came to an end last week, when after hearing numerous witnesses, the jury returned a verdict of accidental death. Dr. Edgar, chemical inspector for the Department of Explosives Supply, said that a bad "fuming off" had evidently occurred during the nitration operation in the manufacture of "T.N.T." such as had happened, though not frequently, at other factories. The fumes were caused by an abnormal chemical reaction, which might have arisen in a number of ways. The liquid inside the nitrator might have become overheated and boiled over, thereby setting the surrounding staging on fire. The roof, he thought, was caught by the flames leaping up from the nitrator, and the fire would then spread to the room in which the T.N.T. was stored. The best evidence that the explosion must have taken place in the packing room was the fact that immediately below where the kegs of T.N.T. had been was a crater 25 yards by 10 and about 5ft. deep. So far as he knew, this was the first big explosion which had taken place in a factory where T.N.T. was being made; he had known of cases where large quantities of T.N.T. had caught fire and burned away without explosion. Speaking on behalf of Dr. Addison, Major Corbett said it was a piece of extreme ill-fortune that the explosion should have occurred, for it had been decided by the Ministry of Munitions to close the works within a few days in accordance with the policy to close down one by one the private works in the large centres of population.

BARROW-IN-FURNESS, Thursday.

Hematites.

Whilst there is no change to report this week in the hematite pig iron trade of this district there is no falling off to note in the industrial activity. The demand for iron is still heavy, and makers have their hands full of contracts, and are doing their best to give delivery. Locally a big tonnage is being used up at the steel works at both Barrow and Workington, and other local users have considerable requirements, whilst on outside account the demand is steady, especially for the higher grades of metal. In all there are thirty furnaces in blast, and there is no immediate prospect of any additional plant being put into operation. Prices are steady at the maximum rate of 127s. 6d. per ton for mixed numbers of Bessemer iron, and special brands are at 140s. per ton, both f.o.t. The stores of warrants stand at 450 tons. No business has been done for some time.

Iron Ore.

There is a very keen demand for hematite iron ore, not only on local but on general home account, and raisers have more on than they can manage. The output of ore is very big, but further developments are necessary in order to secure an additional tonnage. These developments are being made in both Furness and Cumberland.

Steel.

In the steel trade there is marked activity at Barrow and at Workington, and every available branch is running at full pressure. The demand for semi-manufactured steel is heavy, on local as well as general home account, but finished steel is quiet. Prices are unchanged, with heavy rails at £10 17s. 6d. to £11 10s. per ton, light rails £14 to £14 10s., heavy tram rails £14, billets £12, ship plates £11 10s., and boiler plates £12 10s. per ton.

Fuel.

There is a keen demand for steam coal all through this district, and good sorts are quoted at 25s. to 27s. 6d. per ton delivered. House coal is in fair demand at 27s. 6d. to 37s. 6d. per ton delivered. For coke there is a full demand, and East Coast qualities are at 33s. to 35s. 6d. per ton, and Lancashire qualities are at 31s. per ton delivered to West Coast works.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE Cleveland pig iron trade presents few new features of interest this week. There is an abundance of iron for home requirements, and although the demand this month has been rather less, owing to the holiday period and other factors, there is every indication of renewed activity in August. There are tentative inquiries out already for next month, and while most consumers are inclined to adhere to their monthly allocations, some are still disposed to contract ahead. The export position shows but little change, but the tonnage outlook would appear to be rather better, and a further improvement in the shipments is looked for. There has been no withdrawal for several weeks from the stock of Cleveland pig iron in the public store, the amount still standing at 1137 tons, all of No. 3 quality. For home consumption No. 3 Cleveland pig iron, No. 4 foundry, and No. 4 forge are firm at 92s. 6d., with a premium of 4s. for No. 1. The export quotations are as follows:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

The general position in the hematite pig iron trade of this district is unchanged. The pressure of the demand increases rather then otherwise, rendering the work of allocation more difficult. Home requirements are being adequately met, and the amount available for the Allies is being carefully allotted. The demand is very heavy, and the applications are so dealt with as to ensure, as far as possible, the satisfaction of the minimum needs of the Allies works. The maximum home price for East Coast mixed numbers remain at 122s. 6d. The export quotations are nominal at 137s. 6d. to France, and 142s. 6d. to Italy.

Iron-making Materials.

In the foreign ore trade an almost unlimited volume of business is being offered at the official rates, but business is of quite a hand-to-mouth description. The tonnage position is certainly better, and deliveries have improved, but the demand is heavy and continuous. Coke, while by no means over plentiful, is in adequate supply. Prices are unaltered, good medium furnace kinds realising round about 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

Throughout the Northern district the activity in the manufactured iron and steel trades is very marked. Manufacturers continue to be faced with the difficult problem of satisfactorily meeting all the demands put upon their resources. Production remains on a high level, but the Government alone can easily absorb the entire output, the naval and military requirements being more urgent as time goes on. There is thus little or no material available for the use of ordinary home consumers, while the new regulations regarding the export of iron and steel have practically shut the door to oversea trade. Very large quantities of material are now being liberated for the rolling of ship and boiler plates. The insistent demand for these descriptions of material has greatly accelerated the activity at the rolling mills. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ⅜in. and upwards, £13 10s.; $^{9}/_{16}$in., £13 15s.; ½in., £14; $^{5}/_{16}$in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

The position in the scrap trade seems to be firm all round but quieter. There is not the same urgent inquiry for ordinary steel scrap, and it seems that consumers have fairly well satisfied themselves for the present. But as the market has been cleared of accumulations the

position of dealers is quite comfortable, and there is not likely to be any giving way of prices. With regard to cast scrap for the foundries there is a renewal of activity, and if the position of foundry iron becomes worse there will soon be an unprecedented demand for foundry scrap. Dealers realise this and are rather cautious about depleting their stocks. There is very little alteration in the heavy wrought iron scrap position. No sign of any modification of the restriction in prices is to be seen. Small dealings are reported, but the quantity involved is very trifling, and the regular trade is still in abeyance. Current prices are :—Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, ¾in. thick and over, £6 5s.; heavy wrought iron scrap, ¾in. thick and over, £5 5s.

The Coal Trade.

Operations in the coal trade have been more restricted than ever this week. The new regulations respecting minimum prices have created a feeling of uncertainty in the matter of future business. Many difficult points have yet to be cleared up, and in the meantime exporters and buyers are hesitating to commit themselves to new business. The new schedule of prices has also automatically scrapped many standing arrangements between collieries, shippers and their clients, and necessitates the reorganisation of prices. While the general export trade has been somewhat quiet, it is gratifying to note that the collieries have been considerably helped by the stemming of vessels for official requirements. The new order regulating the sale of coal for delivery on railways according to area of production, with a view to the most economical utilisation of all available rolling stock, also comes in for a good deal of discussion. It is, however, too early as yet to estimate the effect of this Order, as the coal trade in general has not yet fully assimilated the conditions. There is, however, a great amount of speculation as to the effect of the Order on Durham, where it is freely stated the production is far in excess of the requirements of the prescribed area. It is therefore contended that there will be some amount of idle time in the county unless better facilities are given for the shipment of the surplus production. At the moment the little business that is being done is chiefly confined to the higher quality coals, which easily command late figures. Quotations are as follows :—Northumberlands : Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade ; 28s. 6d. to 30s. for export ; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. 6d.; North Northumberland smalls, 20s.; seconds, 18s. 6d. Durhams : Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; best, 25s.; superior, 30s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SHEFFIELD.

(From our own Correspondent.)

"More Wages and Pleasanter Work."

AN experience of the Applied Science Department of the Sheffield University may have sounded a little amusing when heard at the Munitions Tribunal here the other day, but it must have been no less annoying to the authorities concerned. Ever since the war began this Department has done very useful work for the Government, and is busy just now on productions involving cupro-nickel and brass castings. The University has parted with so many men for the fighting line that latterly there has been some little difficulty in keeping a suitable staff together for the work referred to. In these circumstances assistance was sought in Ireland, whence half-a-dozen healthy harvesters were brought a few weeks ago. Their fares were paid, and they were to receive £2 per week for a start, whilst within a month they would have become, with quite ordinary application, partially skilled workers, and as such could have earned 9s. a day. Their migration to Sheffield had cost the Government £5 per man, and the University authorities had procured cheap and comfortable lodgings for them at the munition hutments, to which I have referred from time to time. But, like Galleo, they "cared for none of these things," and after a fortnight three of them managed to slip back across to Ireland, and the other three applied at the tribunal for leaving certificates, which were refused. The representative of the University said that no objection was raised to the men returning to Ireland if they wished to do so, but it was desired to prevent them obtaining other work in this country. Each man on leaving Ireland had been given a card, showing that he was held to be ineligible for military service so long as he retained the employment shown on the card. In the event of his leaving that special employment it was his duty to go straight to the labour exchange and report, otherwise the protection of the card would cease. The excuse of these sons of Erin for wishing to leave was a desire for more wages and pleasanter work.

The Labour Outlook.

Considering the very heavy toll put upon the ranks of labour in this district for service with the colours, it is nothing short of wonderful how firms have managed to carry on as well as they have done, but the fact that six men had to be brought over specially from Ireland reveals the actual nakedness of the land. There is, indeed, a severe dearth of the right sort of men, and the opportunity now offering for a quick cut into skilled labour is great. All kinds of trained men are required, and, failing these, the only thing is to give a chance to semi-skilled and even unskilled labour. In this way many men who, before the war, had either lost all their chances or had had none to lose, and were earning scarcely sufficient to keep body and soul together, are now quite efficiently performing skilled tasks and earning good wages. But this very fact, satisfactory as it is at the moment, causes a considerable degree of anxiety when viewed in the light of the future. Manufacturers here are perfectly cognisant of the fact that one of the chief foundation stones in the reconstruction of industry is labour. If, as the Re-construction Committee recommends, trades union conditions and rules must be fully restored after the war unless Labour, in conference with Capital, arrives at any other conclusion, there is a strong feeling in the Sheffield area that Labour leaders, as well as capitalists, will be called upon to take a very long and broad view of things. Directors with whom I have spoken on the subject point out that the who'e condition of industry will have been so revolutionised by the time peace comes that to insist upon a reversion to pre-war rules and regulations, without at least drastic qualifications, would be rank folly on the part of either employers or employed. It is an excellent augury for the future that already in this district the two sides are coming together to discuss problems so vital to the interests of both ; but that of itself is not sufficient. Employers are very candidly conceding the point that permanently increased outputs must be met by equal facilities, and even encouragements, for the regular earning of high wages Labour, if it sets the true perspective, will doubtlessly see that in the new industrial era most of the men and women who came to the nation's aid at a moment of emergency will have to be retained in order effectively to carry out the trade expansion policy by which both Capital and Labour are to benefit financially. In agreeing to a measure of this kind, Labour would be conferring a boon upon the less fortunate members of its own community by giving them another chance under new conditions. From that point, in the view of some people here, every worker should join up with a trade union, and every firm be a member of an employers' federation, for the greater convenience of negotiation ; and from that point, too, the apprenticeship question, for the sake of the nation's future supply of skilled men, should be settled upon a sound, permanent basis.

A Building Problem.

The continued pressing need for works extensions is leading to the demolition of a great deal of old property in the more congested parts of the city, property which ought to have been swept away long ago. For instance, the provision of an additional packing-shed for Thomas Firth and Sons means that sixteen houses must be demolished. That is all right, but the problem of how the present occupants are to be housed is becoming a serious one, especially as no building worth speaking of, of a private character, is in progress. There is an absolute house famine in Sheffield. Working people, whose allowance for rent and rates ranges between six and seven shillings a week, advertise their willingness to pay £1 or even £2 commission to anyone securing them the offer of a cottage at that rental. There is still plenty of room to be had by pulling down "rookeries," for it is estimated that of the round 100,000 houses in the Sheffield city limits, 24,000 are not really fit for human habitation ; but the work of demolition goes on without compensation by the building of suitable dwellings in the healthy rural districts which abound. In the first two full years of the war less than 900 houses were erected, and in the first quarter of the present year only two were certified, whereas the Estates Committee's estimate of the city's requirements is that 2500 houses at least should be built every year for some time to come. So serious has the question become, that the corporation is recommended by the committee to build 800 houses a year, leaving 1700 to be built annually by private enterprise. Something drastic will certainly have to be done, for the population increases at the rate of 5000 a year, whereas in recent times as many as 1000 dwellings have been demolished, chiefly to make room for works. This is a phase of industrial re-construction which cannot be overlooked. The workers must be housed, and properly. It is one of the things they will demand in the future.

Exports to the United States.

From the American Consul (Mr. John M. Savage) I have received some interesting figures relative to Sheffield's exports to the United States for the six months ended June 30th, and in nearly every case the restrictions upon overseas trade are very plainly indicated. The value of agricultural implements exported to the States from Sheffield in that period was 5402 dols., compared with 6007 dols. in the corresponding period of the previous year ; the exports of scrap iron and steel fell from 88,920 dols. to 21,751 dols.; steel from 902,019 dols. to 715,207 dols. ; cutlery from 98,030 dols. to 72,621 dols. and "all other manufactures of iron and steel" from 30,694 dols. to 29,117 dols. Put into tons, scrap iron and steel fell by 2886 tons, whilst the exports of steel (high-speed apparently) fell to the extent of 2,280,446 lb., and cutlery by 18,094 dozs. Electro-plate and silverware were chief amongst the exports, showing an increase, the figure in this case being over 3000 dols. higher than for the first half of last year.

The Taxation of Stocks.

So far as the situation created by the taxation of stock valuations can be said to have been saved for manufacturers when the Finance Bill came up for consideration on report in the House of Commons on Monday, Sheffield claims the accomplishment. From the moment they realised what that section of the Bill was going to mean to them the steel firms here have been very keen about the matter, and it was their initiative, I believe, which, at an earlier stage of the measure, led the Chancellor of the Exchequer to promise a White Paper with a view to meeting the protest made at that time. The terms of the White Paper, however, failed to reassure them and they were largely instrumental in bringing about the deputation of sixty members that awaited upon Mr. Bonar Law on Friday last. Fully forty representatives of Sheffield's interests went up to Westminster on Monday to hear Sir Samuel Roberts, the recently knighted member for the Ecclesall Division of Sheffield, second the amendment which the Chancellor would not accept. The extension to two years of the period to be allowed after the termination of the war in which to ascertain, by actual realisation, the value of the stock appearing in the account at the end of the last accounting period, and to make an allowance from the profits of that period for any difference between the valuation and the sum realised was a good point gained. The original White Paper proposal of one year was, they contended, ridiculously inadequate, and even the two years are only of value by comparison. Actually it leaves them, they consider, in a very slightly improved position, because there are so many other anomalies in the proposal that it could not be made just in their view without reframing. This the Chancellor has refused to do, but I believe the manufacturers have not turned the last stone yet in their endeavours to right what they believe to be the wrong, so that more may be heard of the matter. As to the attitude of Labour, referred to with significance by the Chancellor, firms here are strongly convinced that trades unionists see the justice of their claim. An illustration of what is meant by the taxation of paper profits may be furnished by the case of a firm, say, that finds itself compelled, for the sake of guaranteeing continuity of a great business, to maintain stocks of Swedish steel at 4000 tons. The actual value of the material is about £15 a ton, but what with submarine perils, and other war risks and conditions, another £30 at least has to be added to the cost of the delivered goods at the present time. Is a firm, because it replenishes stocks at a normal level, to be taxed on the £45 per ton with the risk of having to sell at a third of the value at some time or other ? Instances, manufacturers say, could be multiplied. They have no objection at all to bearing their full share, and even more, of excess profits taxation, but the capital value should be inviolate. If they, for any reason, should find themselves under the necessity of reducing stocks below a fair working level the prospects for industrial reconstruction might receive a bad set-back.

Round the Works.

There is not likely, I learn, to be any development at present of the £2,000,000 electricity scheme mentioned in one of my recent letters. The matter, for various reasons which cannot be gone into here, has been apparently shelved, but steps may be taken to bring about modified schemes so arranged that eventually, when the time is ripe, they may be worked into the larger plan. Whatever difficulties may present themselves at the moment, it is certain large things will be done as soon as circumstances permit. New War-office contracts have been placed here for butchers', table and clasp knives, forks, stoves, and portable boilers, wire rope, wheel-barrows and tools. Recent oversea business booked includes steel for Capetown, Montreal, Yokohama and Hong-Kong ; knives for Oporto, Bahia and Toronto ; tools for Montreal, Quebec, Cartagena, Bombay, Calcutta, Madras and Antofagasta ; sheep shears for Buenos Aires ; saws for Havana and Bangkok ; machetes for Calabar ; machine knives for Bangalore ; hardware for Bombay ; cutlery for Montreal and Toronto ; and electroplate for Valparaiso and Talcahuana. The overcrowded condition of warehouses, owing to traffic delays, is exemplified in a curious incident. A picture palace building, just completed in readiness for equipment internally, has been taken over by the Dannemora Steel Works, which it adjoins, and is being used as a warehouse, where hundreds of tons have already been placed. This and other tool-making firms are loaded with orders, there being sufficient on their books to last for two or three years. Makers of farm and garden tools are endeavouring to eliminate fads in design by limiting manufacture to a few essential patterns that will do all the work required.

Iron, Steel, and Coal.

Supplies of hematite pig iron, particularly of the special qualities, are being delivered fairly well, but the market for Derbyshire foundry is distinctly tight, so many furnaces having been put on to basic. Lincolnshire makes are still off the market for Sheffield. Steel is in increasingly heavy demand on Government account, and for general requirements it is difficult to procure. Bar iron is in very strong request, and scrap of all kinds finds eager consumers. Steam coals show little change on the week. Almost all the exports are on account of Allies, except, of course, Government requirements. Nuts are in strong demand, and slacks move freely, though an easiness is rather expected in the market. House coals are firm. Collieries are furnishing to the Coal Controller returns of supplies to restricted and prohibited areas during June, and these will be taken as a basis of supplies after September 8th, when the new order comes into operation. Best South Yorkshire steam hards quote 18s. to 18s. 3d.; best Derbyshire, 17s. to 17s. 3d.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 17s.; best hard slacks, 12s. 6d. to 13s.; seconds, 12s. to 12s. 6d.; soft nutty slacks, 12s. to 12s. 3d.; pea slacks, 6s. to 7s. In house coals, branch quotes 21s. 6d. to 22s. 6d., and best Silkstone 18s. 6d. to 19s. 6d. per ton at pit. Coke is firm.

SCOTLAND.

(From our own Correspondent.)

Holiday Markets.

BUSINESS in Scotland has been almost entirely at a standstill during the past week owing to the holidays. The stoppage this year has been more prolonged than ever before, extending to practically every branch of industry. In the iron, steel, and allied industries works are only open in order to make the necessary repairs and additions to machinery, while, with regard to the coal trade the present is the first occasion on which all the Scottish districts have taken their holidays simultaneously. A general resumption of operations will take place on Monday, 23rd inst.

Pig Iron.

The situation in the Scotch pig iron trade is unchanged. All grades of material, and especially hematite, are in constant demand on war account, and the pressure on the works is fully maintained. Consequently, ordinary home consumers are receiving scant attention, and exports are still confined to the requirements of the Allies. Quotations are firm and unchanged.

Quotations.

Monkland and Carnbroe, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglington, at Ardrossan or Troon, and Dalmellington at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

In all departments of the iron and steel industry war requirements dominate the position. Private consumers at home and abroad are getting very short of supplies, and stockyards are down at the lowest levels. American sources of supply, too, are drying up on account of increasing war demands, so that the mercantile trade generally is suffering from a severe shortage of finished material. In the steel trade all energies are concentrated on the output of war material. Limited quantities are being shipped to France and Italy, but otherwise the export department is inactive. Prices are unchanged. The demand for black sheets is very insistent, especially for the heavy gauges. Galvanised sheets are scarce, and even at £29 for corrugated and £30 for flats, which many would willingly pay, there is nothing on the market. In the malleable iron trade makers have full order-books, and a resumption of work will see full employment in all departments. As in other trades, ordinary business is practically at a standstill. Values are unaltered. Machinery manufacturers are particularly busy. In the structural and engineering trades there is intense activity, and the present brief holiday will be a pleasant respite. Shipbuilding, too, is making great strides, good progress being made with all classes of work on hand.

Coal.

The whole tendency in the Scotch coal trade continues dull and quiet. In the West of Scotland district the industrial demand is fully maintained, and collieries are getting fair employment, but in Fifeshire and the Lothians the outlets for colliery produce are narrowing down, and idle time is prevalent. Some collieries are only working three days per week. Prices are at last week's level. Best ells are quoted f.o.b. at Glasgow, 26s. 6d. to 28s.; splints, 28s. to 30s.; navigation, 28s. to 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s.; first-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s.; first-class steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The aggregate shipments from Scottish ports during the past week amounted to 161,373 tons, compared with 160,364 in the preceding week, and 216,384 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Cardiff Coal Trade.

THERE has been no development of note in matters appertaining to the coal trade. It was expected that the official classification of the various coals would be issued this week, but, so far, it has not been made public. It is understood that the list as drawn up by the Committee has been forwarded to the Controller of Mines for his approval. Several firms have, it is reported, appealed against the grading as it concerns them, but exactly what they can do in the event of the decision being unsatisfactory, is not clear. The question has even been raised in one quarter as to whether the authorities have the legal right to classify coals in a manner disapproved by the coalowners interested, and there has been talk of a meeting of protest against the whole scheme of prices, &c., being organised, but this course does not, apparently, meet with much support, and as far as can be ascertained is not being pursued.

Small Coal Question.

The problem of dealing with the accumulation of small coals, which has frequently been the cause of temporary suspension of work at a number of collieries, has for some time past received the attention of the Admiralty authorities. It is hoped that some measure of relief will be shortly secured, as negotiations have been in progress for some weeks for the reopening of the Cardiff coal washery, which was closed shortly after the outbreak of war. This washery is capable of dealing with a substantial quantity of small coals, probably 8000 or 9000 tons a week. These works were erected some years ago, and the washed coals were shipped to Italy. It is understood, however, that the amount of success to be secured by the arrangement for the reopening of these works, and its effect upon relieving the situation as regards inferior grades of smalls, depends very largely upon how far colliery owners are prepared to meet the Admiralty authorities on the question of the price for the supplies of smalls, so as to permit of the washed product being obtained at an acceptable cost.

Miners for France.

Two miners' leaders, viz., Mr. Daniel Davies, chairman of the Anthracite Miners' Association, and Mr. J. D. Morgan, miners' agent, are on a tour of inspection in France, with the object of finding out whether a scheme suggested by the Coal Controller is workable. The scheme put forward is for men from the West Wales anthracite district to be taken over as volunteers to work in French mines for the duration of the war.

Degrees in Technology and Commerce.

Principal Coles submitted at a recent meeting of the Cardiff Technical Instruction Committee a report on the proposed joint university courses in technology and commerce. He pointed out that the scheme was, as yet, only in its initial stages, but it was probable that before very long technical college students by means of these courses would be able to secure degrees in technology as well as in commerce, and the effect on local commerce and industry in producing a new race of men to officer the industrial army was likely to be great. Cardiff would be ready for the inevitable reconstruction in education which would follow the war, and South Wales was likely, before many years, to be in a position to give a strong lead to the country in higher technological and commercial education.

Miners' Holidays.

The Executive Council of the South Wales Miners' Federation has decided that the workmen should take three days' holidays as usual, commencing on the first Monday in August.

Miners and Recruiting.

At a meeting of the Conciliation Board for South Wales, on Wednesday, Mr. Finlay A. Gibson, the owners' secretary, announced the receipt of a communication jointly signed by Sir Thomas Ratcliffe Ellis, the Secretary of the Mining Association of Great Britain, and Mr. T. Ashton, the Secretary of the Miners' Federation of Great Britain, enclosing a scheme which had been agreed upon, and which had received the approval of the Coal Controller, with reference to the additional number of men required for the Army from collieries in the United Kingdom. The owners suggested that a joint committee should be appointed to carry out the necessary arrangements under the scheme. The workmen's representatives said that they had only received the proposals that morning, but would give a reply to the owners' suggestion as soon as possible. The scheme deals with the combing out of single men from eighteen to twenty-five years of age.

How Strikes are Made.

Since Friday last about 1200 workmen at the Bedwas Navigation Colliery have been idle as the result of a dispute between one workman and one official. Shortly, the facts are, it is alleged, that an underground official provoked a workman to such an extent that he caught hold of the official by his shirt collar. The management alleges that the official was badly assaulted. The result was that the workmen stopped work and demanded the dismissal of the official and the re-instatement of the workman. The matter came before the Conciliation Board on Wednesday, when Mr. E. M. Hann was asked to meet Mr. Hubert Jenkins—miners' leader—in order to endeavour to arrive at a settlement. The owners protested very strongly against the workmen stopping work without notice.

Current Business.

Business has been in a very stagnant condition. It was thought, last week-end, that an improvement would have been seen by this time, but expectations have not materialised, and, as far as can be ascertained, there is no immediate prospect of improvements. Schedule prices have been quoted, but now that these admit of no variation, colliery salesmen have to depend upon their contractors and friends for orders, seeing that no monetary concession can be offered. There is no immediate prospect of the market becoming so firm as to enable colliery owners to charge more than the schedule prices for neutral business, which they are entitled to do, if the conditions are sufficiently favourable to admit of them securing higher figures. As things are, salesmen would be glad to get prompt orders at the scheduled list of prices, as stocks are so heavy as to jeopardise regular working. All classes of coals are suffering in this respect, and a considerable amount of time has been lost at the pits. Apart from supplies for export, house coals have been in good demand at the limitation levels. Patent fuel, which is not scheduled, is generally quoted at 30s. Coke making is rather more active, as stocks have been worked down, and the price of 47s. 6d., which is the fixed price, holds good. The market at the moment is not sufficiently strong to enable firms to quote more for neutral sales. Pitwood has been very erratic, and dependent, very largely, on the facilities which collieries could offer in the matter of wagon supplies. Those collieries which could supply wagons have been able to command concessions upon the price of pitwood, and in the case of a mixed cargo of principally 6½ft. lengths, business was done at 57s. 6d., but there is a good demand for 9ft. lengths, which are scarce. Quotations are now about 60s. to 62s. 6d.

LATER.

There is no change in the market or the conditions prevailing, but an interesting communication has been received from the Controller of Mines, relative to contracts entered into prior to May 1st last, at prices under schedule figures. The Controller's view is, that the directions do not interfere with such a contract as between the seller and the buyer, but in the event of the buyer now wishing to sell that coal, whether to a person in this country or abroad, he must charge for such coal the fixed schedule price. If the sale is to a person abroad he must also charge commission and brokerage. The interpretation thus given by the Controller is different from that held by members of the trade, and is inimical to the interests of the middleman, whose position for some time past has been anything but enviable. Up to now, middlemen who held low-priced contracts were prepared to sell to *bona fide* exporters at a price lower than the schedule figure, but the decision of the Controller is, that he cannot sell to anybody at less than the schedule, and the effect is to drive business more directly to the colliery salesmen. As a matter of fact, there are few contracts that are below the prices set out in the schedule, and contractors, therefore, who ship their coals to France and Italy, lose money on them. The only way in which they can sell at a remunerative figure is by disposing of them to buyers abroad, in countries other than France and Italy, inasmuch as the schedule prices in such cases are minima, but the difficulties of carrying through business for neutrals are very great, and the chances very small.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. Coke, 47s. 6d.; pitwood, ex ship, 60s. to 62s. 6d.

Newport.

The inquiry for coals is restricted, and this restriction has been reflected in fairly numerous temporary stoppages, owing to stocks of coal being so heavy. Small coals particularly have accumulated. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 23s.; seconds, 21s. 6d. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s.; pitwood, ex ship, 60s. to 62s. 6d.

Swansea.

Business has been exceedingly quiet, and the conditions generally have been slack. Anthracite large have ruled easy, but machine made descriptions have been comparatively active, inland requirements being on a fairly good scale. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; Big Vein large, 27s. 6d.; Red Vein large, 25s. 6d.; machine made cobbles, 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine made peas, 20s.; rubbly culm, 13s.; breaker duff, 10s.; billy duff, 6s. 6d. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, through, 25s.; smalls, 19s. Bituminous coal: Through and through, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates, &c.

There is no change in the tin-plate trade, which however, is very firm, and prices tend to appreciate. Values are about 36s. to 37s. per box I.C. 14 × 20 × 112 sheets, under Class A certificates. At meetings recently held, tin-plate and Siemens steelworkers made claims for up to 100 per cent. additional war bonus. The existing war bonus at Siemens steel and tin-plate works ranges from 37½ to 57½ per cent., according to wages earned. Of this, 15 per cent. to 20 per cent. has been operative only since April 30th. Quotations:—Block tin, £239 per ton cash; £236 per ton three months; copper, £130 per ton cash; £129 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

TECHNICAL COMMITTEE OF THE MOTOR INDUSTRIES.

THE third meeting of the Technical Committee of the Motor Industries was held at the offices of the Institution of Automobile Engineers on Tuesday, June 19th, 1917, when many important questions were discussed.

Mr. A. A. Remington—Wolseley Motors, Limited—was elected chairman of the Committee for the year; Lieut.-Colonel R. K. Bagnall-Wild being elected vice-chairman.

Among other matters upon which a definite conclusion was reached was the adoption of the suggestion of Mr. W. H. Paull, that the time is now ripe for a serious effort to be made to introduce an international standard of wheel and tire rims for solid rubber tires. It is suggested that France, U.S.A., Italy and Russia would be willing to co-operate with Great Britain in this direction. This view has been forwarded to the Engineering Standards Committee.

Steps are being taken to collect data on several subjects of proposed research, and in this connection an important proposal has been made to the Committee that a bureau of technology should be established where all technical information with regard to various branches of the motor industry may be obtained, and from which would be issued a periodic *précis* of up-to-date information relating to the latest advances of science, and the possibilities of their application in the realm of automobilism. Such a scheme might be of immense service to the engineers of the automobile industry, but it cannot go through without the financial support of the firms, although it is quite likely that the Government would, through the Department of Industrial Research, make a substantial contribution to income. As yet the subject has not received any detailed consideration, but it is one on which those interested are invited to express their views.

Another view of great importance that has been brought before the Committee is the proposal to form a central organisation for the better co-ordination of engineering training, and in this matter the Committee is already giving all the support that has been asked of it at the present juncture.

The Committee is now represented on all the Engineering Standards Committee Automobile Sub-Committees, and steps have been taken to render every assistance in this direction. Steps have also been taken to ensure the proper representation of motor industries on the Civil Aerial Transport Committee, as there is no doubt that mechanical transport must play a very important part in any such scheme.

PERSONAL AND BUSINESS ANNOUNCEMENTS

THE Aeronautical Institute of Great Britain asks us to state that its second London course of preliminary aeronautical training, which will be much extended, will commence in the first week of August, and that full particulars concerning the London Centre can be obtained from the Institute, at 3, Arlington-street, S.W. 1.

ENGINEERING SCHOLARSHIPS AND DIPLOMAS.—The following awards have been made in the Faculty of Engineering at University College, London:—Goldsmid Engineering Scholarships—Third year, P. S. J. Bovey; second year, A. A. Clements. Engineering diplomas—Civil and Municipal, A. Ezcurra; Civil and Municipal, D. R. Sethi.

RAILWAY CONSTRUCTION IN PERU.

UNDETERRED by the stringency in financial circles and the fact that the rate of exchange is against the country, the Government of Peru is resolved upon a considerable extension of its by no means large railway mileage, and at the present time there are four different constructions in hand, of which one, at least, is of supreme importance, and destined to have a very great effect upon the future economic prosperity of the Republic. The Lurin railway is a strategic line running along the south coast of the State, and it is the wish of the Government to develop it to the fullest extent and without any delay. To this end an arrangement has just been completed by which the Peruvian Corporation, a British concern which already owns or operates all the principal systems of railway in the country, shall carry out the whole of the remaining construction. Rails now extend some thirty-five kilometres south of the capital—Lima—as far as the small town of Lurin, situated in the valley of that name. Orginally it was intended to extend the line to the small port of Chilca, but it has been finally decided to throw the route further inland through Mala; it is considered that if carried to Chilca producers would ship their consignments to the port and thence to Lima by sea, thus robbing the railway of the traffic and rendering the enterprise unprofitable. By constructing the line inland an additional advantage will be gained. The close proximity of the rails to the coast would have exposed them to easy shelling by any hostile warship lying offshore. Up till now but £P100,000 have been expended upon the construction of the Lurin railway, but a very much larger sum will be devoted to its completion and equipment—it is hoped—with British-made rolling stock.

A North American (Pittsburg) interests are concerned in the construction of the Mina-Raga railway, destined to connect some valuable vanadium mines by means of a short branch with the existing Cerro de Pasco and Central railway systems. Starting from a point near kilometre 109 on the first-named railway, the Mina-Raga branch will run approximately due west for 20 kilometres to the eastern end of the Lake Punrun. Upon this section the gradient will probably be 3 per cent., and the gauge will be standard. The starting point is situated at an elevation of 13,688ft. above sea level, while the objective point, Lake Punrun, is at an elevation of 14,800ft. The intervening stretch of territory is rolling country or pampa, affording unusual facilities—in Peru—for rail-laying, once the necessary material can be brought to the spot. At the terminal at the eastern end of the lake some 12 kilometres of lake navigation will be necessary, and this it is proposed to provide by means of barges and a tug-boat, or, alternatively, by a car-ferry. The idea of constructing a line around the lake has had to be abandoned on account of the rocky nature of the land and the prohibitive cost of dealing with it. Should the barge part of the programme be carried into effect, Lake Titicáca will lose its proud title of being the highest navigable body of water in the world, for Lake Punrun stands at an altitude of another half-mile above sea level. At the western terminal of the railway there will be constructed a steep decline down which the ore, mined from the vanadium deposits, will descend by gravity to a new concentrating plant to be erected upon the rocky shores of the lake. A large number of heavy rock cuttings will be necessary to carry the railway from the western end of Lake Punrun for a length of eight kilometres, but upon two of these only will the work be serious. Here the gradient will also be one of 3 per cent., the trains having to mount to a height of 16,000ft. before reaching the terminus, at Mina-Raga. This section of the line will be narrow gauge. The entire system will be electrified, the power being obtained from a hydro-electric installation at Jumasha Falls, situated 450ft. high, and where the river of the same name empties into Lake Punrun and develops a power anything between 600 and 1000 horse-power.

The third railway project now being prosecuted is that of the Cuzco-Santa Ana connection, between the Urubamba Valley and the important port of Mollendo. In this enterprise foreign capital will be employed. Several years were devoted to a careful survey of the route, and an American engineer, named Read, was finally successful in locating it. Unfortunately, he did not live to complete his work, while his successor, named Fleming, abandoned the task before finality was reached. Then the undertaking lay in abeyance for some time, Government engineers eventually bringing the survey to completion. Señor Vinas, a distinguished Peruvian engineer, is now in charge of a 20 kilometre (=12 mile) section, the Government undertaking to finance the project to the extent of £P20,000 per annum. The total length of the line will be 104 miles, and the estimated cost of construction is put at £P500,000, or slightly less than £P3000 per kilometre, say, £P4800 per mile. In other parts of Peru narrow-gauge lines have been built for this apparently modest sum, but all railway construction nowadays is far more expensive than it used to be owing to the prime cost of material. Fortunately, the country through which the new line will run offers few, if any, engineering difficulties, while a fair amount of local and efficient labour is available.

The fourth project is one which will require a great deal of outlay; the lowest computation is 30,000,000 dols., say, £6,000,000. This sum the Peruvian Government hopes to raise by means of a foreign loan, mainly in the United States. There is no doubt that the line, if constructed, will rank as one of the most important in the new world, joining up, as it will, the powerful trade current of the Amazon River with the Pacific Coast of South America at the port of Payta. The railway would be known as the "Marañon System," and would, *inter alia*, bring the port of New York thirty-five days nearer to the head waters of the Amazon River.

THE Bombay, Baroda, and Central India Company supplied a number of ambulance trains to the military authorities, who have expressed their appreciation of the very satisfactory and complete manner in which the stock has been built and fitted by the company's carriage and wagon superintendent, Mr. F. Addis, and his staff.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

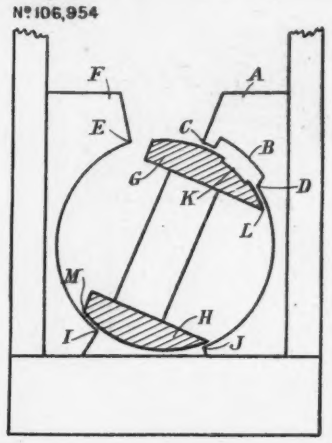
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

106,954 (18,194 of 1916). December 19th, 1916.—MAGNETOS FOR V-SHAPED ENGINES, Abingdon-Ecco, Limited, and another, King's-road, Tyseley, Birmingham.

In V-engine magnetos sparks are required at unequal intervals in the revolution of the armature. To effect this one pole piece A has a longitudinal groove B cut adjacent to its leaving edge, thus providing two leaving edges C D, the angle subtended, between which is one-half the angle between the axes of the V-engine cylinders. The space between the edge C and the adjacent approaching edge E of the other pole piece F is such that the faces G and H of the armature can span the distance from D to E. The space between the opposite pair of edges I and J is made greater than the above, and the leaving edges I and J is so placed that it coincides with one of the edges of the adjacent armature face when the corresponding edge of the opposite armature face coincides with one of the other leaving edges C

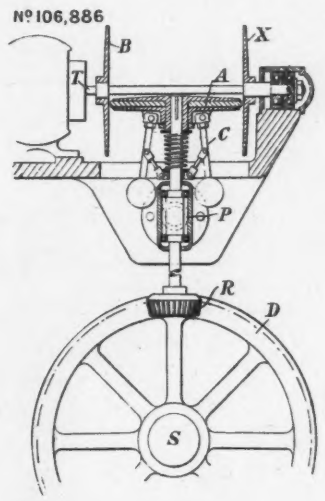


and D. Along the armature face G a longitudinal groove K is cut. This groove lies under the second leaving edge C when the edge L of the grooved face coincides with the edge D. Further, the armature faces G and H are not symmetrical. That is to say, the width on one side of a transverse centre line or diameter is greater than on the other. The maximum sparking position in one-half revolution of the armature is obtained when the armature edge L is adjacent to the pole edge D, the opposite armature edge M being then adjacent to the pole edge I. In the next half revolution the maximum sparking position is obtained when the armature edge M is adjacent to the pole edge C, the armature edge L being then adjacent to the pole edge I.—*June 14th*, 1917.

DYNAMOS AND MOTORS.

106,886 (9277 of 1916). July 3rd, 1916.—FRICTION DRIVE FOR DYNAMOS, William Frederick Wilkinson Rhodes, 8, Toller-drive, Bradford, and another.

This invention is chiefly intended to provide a frictional method of driving dynamos for train lighting, so that the dynamo shaft shall always be driven in the same direction, notwithstanding the direction of motion of the train. The invention is a development of patent No. 224 of 1916. A is a friction pulley combined with a spring-controlled governor C, the whole being

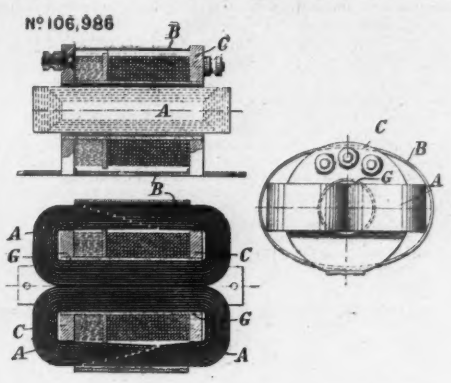


mounted on a shaft-driven gearing from a variable speed source D, such as a wheel on the axle S. The shaft T of the dynamo is extended and has two friction pulleys B X, either of which can be engaged by the pulley A, according to the direction of motion of D, a suitable amount of lateral movement of the shaft and friction pulley A being provided by the swivel bearing P to allow the pressure on either side of the teeth of the wheel R to deflect the shaft from one friction pulley to the other.—*June 14th*, 1917.

TRANSFORMERS.

106,986 (5140 of 1917). April 17th, 1917.—TRANSFORMER, Olivier Loras, 16, Place Bellecour, Lyons, France.

The alternating current transformer constructed according to this invention comprises pieces of thin sheet iron A cut into the shape of strips of different widths and lengths wrapped one on the other, in two sets as shown, round the annular bobbin G; that is to say the strips are passed through the hollow centre of the bobbin and bent over heads C of the latter and again together, so that their ends meet on the outside of the bobbin, forming, in effect, two sets of superposed rings, so as to complete the mag-

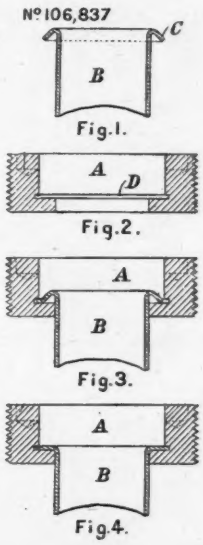


netic field. These strips are held pressed together and secured by means of an oval sheet iron ring B placed at right angles to them, and held in place partly by the edges of the bobbin heads C, and partly by the elasticity of the strips A. The ring B also contributes to the completion of the magnetic field, protects the strips, while, however, permitting of their ventilation, and its surface serves for receiving any appropriate inscription.—*June 14th*, 1917.

ORDNANCE AND ARMOUR.

106,837 (3854 of 1916). March 15th, 1916.—HIGH EXPLOSIVE SHELL, Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester, and others.

This invention is concerned with the method of attachment of the exploder container and the adapter of high explosive shells. The method of construction is shown clearly in Figs 1–4. Fig. 1 is an elevation of the upper part of the exploder container; Fig. 2 a similar view of the adapter, Fig. 3 a similar view showing the exploder container in position in the adapter before the pressing takes place; and Fig. 4 is a view similar to Fig. 3 showing

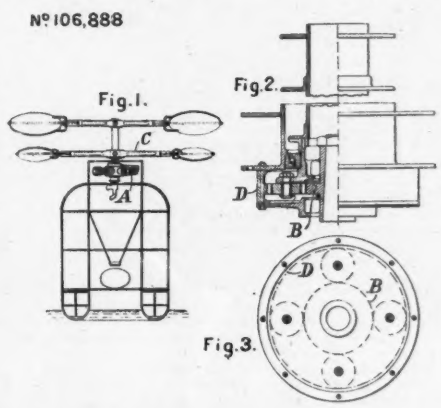


the container pressed into position in the adapter. The improved method of attachment consists in forming an internal circumferential recess above the shoulder of the adapter A, and in so flanging and shaping the open end of the exploder container B that when it is inserted in the adapter the edge C of the flange is opposite the recess D, and the configuration of the flange is such that on the application of axial pressure the container is forced into position, and the flange spreads radially, so as to fill the recess and make a solid joint without brazing, as shown in Fig. 4.—*June 14th*, 1917.

AERONAUTICS.

106,888 (9534 of 1916). July 6th, 1916.—HELICOPTER AEROPLANE, James Robertson Porter, 9, Gray's Inn-square, London

In this machine the helicopter and aeroplane principles are



combined so that the machine may rise vertically or fly horizontally or be deflected from a vertical into a horizontal flight.

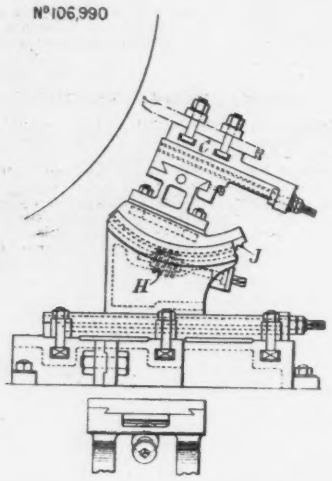
The machine has a body circular in cross-section, the axis of the engine being in the axis of the body, and the engine may be stationary, but is preferably rotary. On the shaft of the engine A is keyed the sun wheel B of an epicyclic or sun and planet gear. A screw propeller C is mounted on a cylinder, which forms part of the annular spur wheel D of the gear, and the planet wheels of the gear revolve on axles which are fixed in a plate carrying a cylinder to which arms are secured. Two or more of these arms carry at their ends aerofoils, the ends of the arms passing through the aerofoils, and the aerofoils may be made so that they can turn freely upon the arms. The aerofoils on their arms are employed as helicopter propeller blades, and the screw propeller fixed to the annular wheel may be constructed in a similar manner, but is for preference of rather less diameter than the propeller fixed to the planet axle plates. Fig. 1 is a view of the machine in vertical section, and Figs. 2 and 3 illustrate the construction of the epicyclic or sun and planet gear. The inventor caims :—"In an aeronautical machine provided with upper and lower horizontally disposed propellers rotated in opposite directions by epicyclic gear driven by an engine, a spur wheel rotated by the engine shaft, planet wheels mounted upon a plate furnished with a hollow shaft whereon one of the propellers is mounted, and an annular spur wheel driven by said planet wheels and furnished with a hub whereon the other propeller is mounted."—*June 14th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

106,990 (5847 of 1917).—SLIDE REST FOR LATHES, Stinton James Jones, Norfolk House, Norfolk-street, Strand, London.

This invention has for its object an improved construction of slide rest having the tool angularly adjustable in a vertical plane about a horizontal axis. The tool carrying portion is provided

Nº106,990



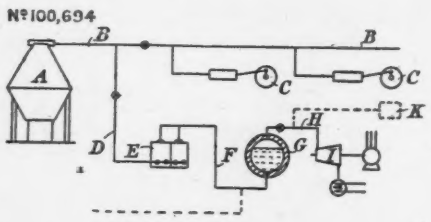
with a curved base, which can be swung backwards and forwards in a curved holder provided on the base of the slide rest. The movement is provided by means of a worm H engaging a curved rack J as shown.—*June 14th*, 1917.

MISCELLANEOUS.

100,694 (8476 of 1916). June 15th, 1916.—POWER GENERATING SYSTEM, Johannes Carl Ruths, 54, Malmskillnadsgatan, Stockholm, Sweden.

This is a combined system for the utilisation of combustible gas in internal combustion engines and steam generators, with the addition of steam accumulators. A diagram of one arrangement in accordance with this invention is given herewith. A indicates a blast-furnace from which a part of the gas, after having been cleaned, is conveyed through the pipe B to the gas engines C, for example, blowing engines or other prime movers where it is consumed. Another part of the gas is conveyed through the branch pipe D to a steam generator E where the gas is burnt. The steam produced in E is then led through the steam pipe F to a steam accumulator G, which contains water under pressure, and at a temperature corresponding to this pressure. The steam accumulator G is connected by means

Nº100,694

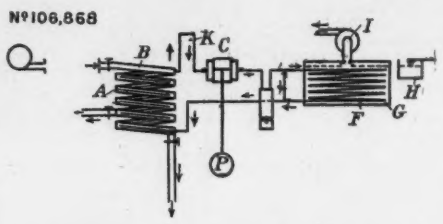


of a pipe H with a turbine I or some other steam consuming apparatus K. With varying load and constant gas supply the greater part of the gas is used in the gas engines that these may take up the constant average load, and the other part is used to make steam in E, and the steam is converted into hot water in the accumulator. The load variations are then taken up by the steam engine. If the gas supply varies and the load is constant, surplus gas is used in the steam generator, and the steam supply, being irregular, the surplus required is made up by the accumulator.—*June 14th*, 1917.

106,868 (8146 of 1916). June 8th, 1916.—REFRIGERATING APPARATUS, George James, 25, St. Andrew's-road, Golders Green, London.

The object of this invention is to provide apparatus in which the circulating pipes usually arranged round the walls of cold storage chambers and much of the other apparatus can be dispensed with. The illustration shows diagrammatically one arrangement of the plant. The liquid ammonia or other medium is subjected to enforced mechanical vaporisation and to mechanical condensation of the saturated vapour, the vaporisation taking place in a vertical vapour pipe K forming part of an inverted U tube arranged at one side of, or in connection with, a heat interchanger A B through which the air or other gas to be cooled flows either naturally or automatically, owing to an increase in density or loss in volume when cooled, or positively assisted by a blower or fan. The air thus cooled in its passage through the heat interchanger is delivered to, and turned free into the chamber to be refrigerated. C is the exhauster and mechanical condenser, driven by some source of

Nº106,868

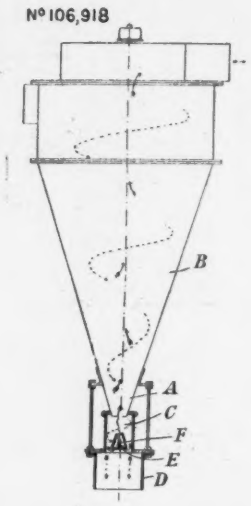


power P. F is a liquid cooling coil in a tank G containing water maintained at a constant level by means of the cistern H. I is an exhaust fan for cooling the water. The ammonia flows in a vaporised state in the direction of the arrows.—*June 7th*, 1917.

106,918 (13,265 of 1916. September 19th, 1916.—CYCLONE DUST COLLECTORS, Thomas Robinson and Son, Limited, and others, Railway Works, Rochdale.

In this cyclone dust collector round the lower end A of the cone B is placed a chamber C of larger diameter than the end of the cone A. The bottom of the chamber C is connected to an air-lock delivery valve D by an opening E. Near the bottom of the chamber C is a hollow cone F, open at the top and bottom and supported so that the falling dust, owing to its rotary motion,

Nº106,918



passes down the sides of the chamber C into the delivery valve D, while any slight amount of air passing inwards from the delivery valve, also any air circulating from the cyclone B into the chamber C, passes underneath and into the hollow of the cone F and up along the axis of the cyclone without disturbing or lifting the falling dust. The dotted arrows show the course of the falling dust, and the solid arrows the uprising air.—*June 14th*, 1917.

SHIPS AND BOATS.

106,968 (1815 of 1917). February 5th, 1917.—PROPULSION OF SHIPS, Harold Edgar Yarrow, Yarrow and Co., Limited, Scotetoun, Glasgow.

According to this invention—in which two or more engines can drive separately, or in combination, the same propeller through the medium of a hollow shaft, and in which gearing is interposed between the main and propeller shafts—the axes of the engines are arranged in the same line. The arrangement is especially useful where a high and a low pressure turbine are coupled by suitable gearing to the same propeller shaft. In this case, the rotor spindle of the low pressure turbine is bored to a diameter which permits the spindle of the high pressure turbine to pass through it. In Fig. 1 A is a high pressure turbine connected by a coupling B to a shaft C, which rotates in the hollow

Nº106,968 Fig. 1.

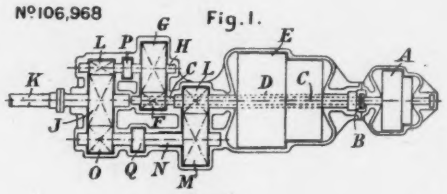
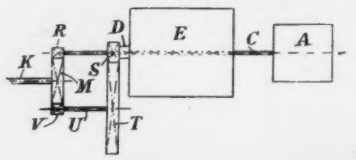


Fig. 2.



shaft D of the low pressure turbine E. On the shaft C is a pinion F, gearing with a wheel G on a second motion shaft H, which drives through a pinion I a wheel J on the propeller or thrust shaft K. On the shaft D of the turbine E is a pinion L gearing with a wheel M mounted on a second motion shaft N, which drives through a pinion O the wheel J. Flexible couplings may be provided at the second motion shafts at P and Q. In the arrangement shown in Fig. 2 the shaft C of the high pressure turbine A, which passes through the hollow shaft D of the low pressure turbine E, carries a pinion R gearing with a wheel M on the propeller or thrust shaft K. A pinion S on the shaft D gears with a wheel T on an intermediate shaft U carrying a pinion V gearing with the wheel M.—*June 14th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of nine of the patents given below £26 and on each of the remainder £18 have been paid in renewal fees.

No. 18,184/10.—Printing, &c. Rotary machines; impression surfaces. A printing machine for fabrics, paper, &c., of the kind in which the impression cylinder consists of a small hard rubber or steel cylinder pressed towards the engraved printing cylinder, is provided with an endless backing-cloth which passes around the impression cylinder and around a tension roller mounted in an arm on the frame of the machine. Mertens, E., Germany. Dated August 2nd, 1909.

No. 18,189/10.—Plastic compositions. A plastic celluloid-like mass which can be worked in the cold state is obtained by adding a considerable quantity of solid or fibrous matter, such as powdered metals, minerals—mica, asbestos, and graphite—powdered glass, inorganic colouring matters, and the like to mixtures of acetyl cellulose and camphor, or camphor substitutes in solution or to the solutions of the acetates. The mass is dried and then moulded, blown, rolled, pressed, or stamped while cold. The material may be employed in the manufacture of packing material, printers' apparatus, electric and heat insulating material. Eichengrun, A., Berlin. Dated August 14th, 1909.

No. 18,371/10.—Pasteurising and transporting liquids. A vessel for pasteurising and transporting beer and other liquids is provided in its interior with a chamber, such as a ball of india-rubber, &c., independent of the inlet and of the walls of the vessel, and completely surrounded by the liquid; the chamber is filled with air, carbonic acid gas, &c., at a pressure greater than the atmospheric pressure, but smaller than that of the liquid during pasteurisation, so that the vessel may be completely filled, the compression of the chamber permitting expansion of the liquid, owing to rise of temperature. During pasteurisation, an additional external expansion chamber may be provided. Wickuler-Kupper-Brauerei Akt.-Ges., Germany. Dated August 3rd, 1909.

No. 18,561/10.—Looms; healds. The eyes of healds are held in the loops of wire healds by their own elasticity, or by the elasticity of the loops. An open or closed ring of flat or round wire is made wider than the aperture of the loop of the heald, and is pressed into place. The heald may consist of one or more wires. Felton and Guilleaume Lahmeyerwerke Akt.-Ges., Germany. Dated August 7th, 1909.

No. 18,702/10.—Brackets. Relates to adjustable shelf supports of the kind in which the bracket is bent at right angles for insertion through a slot in a tubular upright, and consists in providing the side of the upright remote from the slot with tongues behind, which the lower ends of the bent portions of the brackets engage. Wolf, Netter and Jacobi, Berlin. Dated August 7th, 1909.

No. 18,886/10. — Cigarette-making machines. Tipped cigarettes are delivered and sorted according to the ends at which the tips are fixed. Koerner, E., Germany.

No. 19,223/10.—Course-recording apparatus. Comprises apparatus in which the distance travelled by the ship is determined by the revolutions of the propeller or log, and the course is indicated by a compass transmission device, and is resolved by means of a spherical surface into two components at right angles. Anschutz and Co., Germany. Dated May 28th, 1910.

No. 19,224/10.—Mariners' compasses. A secondary compass, controlled electrically or mechanically, to repeat the indication of a magnetic or gyroscopic compass, is provided with a card divided in the usual way, and with an auxiliary card geared to rotate at a higher speed, and differently divided to enable an accurate reading to be taken. The card may, for instance, be divided into ten degrees and geared to rotate thirty-six times as fast as the auxiliary card. Anschutz and Co., Germany. Dated May 30th, 1910.

No. 19,243/10.—Ordnance; built up. Relates to guns that can be taken to pieces for transport, and consists in forming the barrel separate from the breech-piece, and combining the breech-piece with the sliding carriage to form a single piece. Rheinische Metallwaaren-und Maschinenfabrik, Germany. Dated February 21st, 1910.

No. 19,244/10.—Ordnance; breech mechanism. Relates to breech mechanism of the type in which a transversely sliding breech block is closed by a spring accumulator connected to a closing lever, and consists in so arranging the accumulator that the turning moment acting upon the pivot of the lever, when the breech is open, is practically zero, and gradually increases to a maximum as the breech closes. Rheinische Metallwaaren-und Maschinenfabrik, Germany. Dated April 12th, 1910.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters: Balderton-street, Oxford-street, W.

ORDERS

For the week by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—No. 3 Company.

Next for Duty.—Platoon Commander P. Bowden.

Monday, July 23rd.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, Regency-street. Drill. No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, July 24th.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, July 25th.—Drill and Elementary Bridge Construction, No. 1 Company, Right Half Company.

Thursday, July 26th.—Drill and Elementary Bridge Construction, No. 2 Company, Right Half Company. Ambulance Class, 6.30. Signalling Class.

Friday, July 27th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Saturday, July 28th.—Commandant's Parade, 3 p.m. Uniform, for Route March. Fall in Golders Green Station.

By order,

MACLEOD YEARSLEY,
Company Commander and Adjutant.

July 21st, 1917.

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Ministry of Munitions of War.

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ORDER.

STEAM-DRIVEN HIGHWAY LORRIES AND TRAILERS.

The Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm (Consolidation) Act, 1914, the Defence of the Realm (Amendment) No. 2 Act, 1915, the Defence of the Realm Regulations, the Munitions of War Acts, 1915 and 1916, and all other powers thereunto enabling him, HEREBY ORDERS that all persons (other than Railway Companies) owning or having in their possession or under their control any Steam-driven Highway Lorries or Trailers in Great Britain shall, within fourteen days from the date thereof, send in to the Deputy Director-General of Railway Material Licences, Ministry of Munitions, Whitehall-place, London, S.W. 1, Returns containing the particulars with regard to such Steam Lorries and Trailers in the form set out in the tabular statement below, and to make such further Return concerning any such Steam Lorries and Trailers as may hereafter be required by the Deputy Director General of Railway Material Licences.

TABULAR STATEMENT OF RETURN OF

..... Steam Lorries ..... Trailers.

(a) Registered Letters and Numbers.
(b) Owner's name and full address.
(c) Maker of the Lorry.
(d) Date on which they were built.
(e) Working Pressure of the Boiler, Lb. sq. in.
(f) Whether Steam Boiler is fired with coal, coke, or oil fuel.
(g) Name of Insurance Co. for the Boiler.
(h) Net carrying capacity of Lorry in tons.
Net carrying capacity of Trailer in tons.
(i) Weight of Lorry unloaded.
Weight of Trailer unloaded.
(j) Is the Lorry a normal or of a special type?
(k) General condition of the Lorry and Mechanism.
(l) Work (if any) on which the Lorry and/or Trailer is usually employed.

Signed .....

Date ..... Address .....

NOTE.—No separate official form is being issued for the purposes of the above return.

PATENTS AND DESIGNS ACTS, 1907-1914.
BOTTLE-SEALING MACHINES.

The Proprietor of British Letters Patent No. 18,173 of 1912 is prepared to SELL the Patent or to LICENSE British Manufacturers to work under it. It relates mainly to improved machines for gripping the bottle, comprising main jaws and auxiliary jaws, the main jaws being automatically moved to their gripping position when the seal is applied.
Address, BOULT, WADE and TENNANT, 111 and 112, Hatton-garden, London, E.C. 1.
266

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M. Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE comprising

FACULTIES OF ENGINEERING AND METALLURGY.

PROFESSORS IN THE DEPARTMENT.

Mechanical Engineering	W. RIPPER, D.Eng., M. Inst. C.E.	D.Sc.,
Metallurgy	J. O. ARNOLD, D.Met., F.R.S.	
Mining	F. E. ARMSTRONG, A.M. Inst. C.E.	M.Sc.,
Applied Chemistry	I. T. O'SHEA, M.Sc.	
Mathematics	A. H. LEAHY, M.A.	
Physics	S. R. MILNER, D.Sc. (Acting Prof.)	
Chemistry	W. P. WYNNE, D.Sc., F.R.S.	
Geology	W. G. FEARNSIDES, M.A.	
Electrical Engineering	E. H. CRAPPER, M.I.E.E. (Lecturer).	B.Eng.,
Civil Engineering	J. HUSBAND, Inst. C.E. (Lecturer).	B.Eng., A.M.
Glass Technology	W. E. S. TURNER, (Lecturer).	D.Sc.

The subjects in which courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes courses in Civil, Mechanical, Electrical and Chemical Engineering, and students specialise in one or other of these branches in the third year of their course. The course in Engineering extends over three years and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' courses are arranged for Works' Pupils, who come to the University from works in Sheffield, or from other centres, taking six months' study at the University and six months' practice at the works each year.

The DEPARTMENT OF METALLURGY includes (a) the Metallurgy of Iron and Steel, and (b) the Metallurgy of the Non-ferrous Metals. The course in Metallurgy extends over three years, and prepares for the Degree of Bachelor of Metallurgy (B.Met.) or for the Associateship of the University in Metallurgy. The equipment of this Department is on an exceptionally complete and practical scale.

The work of the DEPARTMENT OF COAL MINING includes a three or four years' Diploma Course, consisting of six months at the University and six months at a Colliery.

The DEPARTMENT OF APPLIED CHEMISTRY deals specially with the subjects relating to various branches of Coal mining, and of the Coal and Coke Industries.

The DEPARTMENT OF GLASS TECHNOLOGY provides (a) a Diploma Course requiring systematic study of the science and practice of Glass Manufacture for a period of three years, and (b) Part Time and Special Courses.

The LECTURE COURSES of all the Departments are supplemented by Practical Training in Laboratories, Workshops, and Foundries fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part Time Courses are arranged for students who desire to take special portions of any of the regular courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917.

W. M. GIBBONS, Registrar.
139

THE MANCHESTER MUNICIPAL
SCHOOL OF TECHNOLOGY
UNIVERSITY OF MANCHESTER
(FACULTY OF TECHNOLOGY).

DEGREE COURSES IN TECHNOLOGY.

The Prospectus gives particulars of the courses leading to the Manchester University degrees (B.Sc. Tech. and M.Sc. Tech.) in the Faculty of Technology, in the following Departments:—

MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING,
SANITARY (including Municipal) ENGINEERING.
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Dyeing, Bleaching, Calico Printing, Papermaking, Metallurgy, Fuels, Fermentation Industries).
THE TEXTILE INDUSTRIES,
PRINTING AND PHOTOGRAPHIC TECHNOLOGY.
ARCHITECTURE.

ADVANCED STUDY AND RESEARCH.

The School of Technology possesses extensive laboratories and workshops, equipped with full-sized modern machinery and apparatus, including not only machines of the patterns in general use, but also machines specially constructed for demonstration and original research.

Prospectuses of the University Courses, or of the Part-time Courses, will be forwarded free on application to the Registrar.
17

University of Birmingham.

PRINCIPAL:
SIR OLIVER LODGE, M.Sc., D.Sc., LL.D., F.R.S.

VICE-PRINCIPAL:
DR. R. S. HEATH, M.A.

ENGINEERING DEPARTMENTS.

I.—MECHANICAL ENGINEERING.

CHANCE PROFESSOR: F. W. BURSTALL, M.Sc., M.A. (Cantab), M. Inst. C.E., M. Inst. M.E.
LECTURER: R. C. PORTER, M.Sc. (Vict.), A.M. Inst. C.E.
DEMONSTRATOR: (Vacant).
LECTURER ON MACHINE DESIGN: F. J. BROSCOMB, M.Sc., A.M.I.M.E.
ASSISTANT LECTURER ON MACHINE DESIGN: W. G. WISHART, B.Sc.

II.—CIVIL ENGINEERING.

BEALE PROFESSOR: FREDERICK C. LEA, M.Sc., D.Sc. (Lond.), A.M.I.C.E., A.R.C.S.
LECTURER: W. NORMAN THOMAS, M.Sc., A.M.I.C.E., A.M.I.M.E.
ASSISTANT LECTURERS AND DEMONSTRATORS: ROBERT C. PANTON, M.Sc., M.A., B.A.I., and P. M. CHADWICK, M.Sc., A.C.G.I.

III.—ELECTRICAL ENGINEERING.

PROFESSOR: GISBERT KAPP, M.Sc., D.Eng., M. Inst. C.E., M. Inst. E.E.
LECTURERS: E. J. KIPPS, M.Sc., M. Inst. E.E., and THOMAS F. WALL, D.Sc. (Manch.), D.Eng. (L'pool), A.M. Inst. C.E., A.M. Inst. E.E.
ASSISTANT LECTURER AND DEMONSTRATOR: (Vacant).

THE FULL COURSES EXTEND OVER FOUR YEARS, and students who enter after matriculation and pass successfully the examinations at the end of each year will BE ENTITLED TO THE DEGREE OF BACHELOR OF SCIENCE in Engineering.

THE SESSION 1917-18 COMMENCES ON TUESDAY, OCTOBER 2ND, 1917.

For detailed Syllabus, with full particulars of University Regulations, Lecture and Laboratory Courses, Fees, Scholarships, &c., apply to the SECRETARY.
136

City of Birmingham.—The

Public Works Committee of the Corporation invite APPLICATIONS for the position of SUPERINTENDENT of the Mechanical Department. The person appointed will be required to superintend the repair, maintenance, &c., of steam vehicles and appliances (including road rollers, steam wagons and tractors), petrol-driven and horse-drawn sweeping machines, tar storage tanks, pumps, and distributing machines, stone breaking and screening plant, pumping plant, and other machinery and appliances. He must also have had experience in the control of men and the carrying out of similar duties, and be fully conversant with the tools and machinery required in such work.

No person liable for military service can be appointed.

The candidate appointed will be required to devote the whole of his time to the service of the Corporation, and to contribute to the superannuation scheme, for which purpose he must submit himself to the Corporation doctor for examination, the appointment being subject to the doctor's report being satisfactory.

Applications, accompanied by copies of three recent testimonials, and stating age, experience and salary required, to be sent to the undersigned, endorsed "Superintendent, Mechanical Department."

Canvassing, either directly or indirectly, will be a disqualification.

HENRY E. STILGOE, M. Inst. C.E.,
City Engineer and Surveyor.

Council House, Birmingham,
July, 1917.
263 ▲

Wanted, a Good Practical Man

as RATE FIXER in a large Crane Works, North of England. No person already employed upon Government work will be engaged. State experience and salary.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 304.
304 ▲

Wanted, First-class Engineer to

take charge of large Dyeworks; good salary will be paid to a competent man; no other need apply; must be over military age.—Write, stating age and full particulars of experience, 7044, Williams's Advertisement Offices, Bradford.
285 ▲

Wanted, Manager of a Small

Firm of Engineers and Ironfounders in South-West Lancashire; must be able to introduce a good paying speciality, possess good organising abilities, capable of controlling all branches of the trade, and to influence new business. State full particulars and salary required.—Address, 281, "The Engineer" Office.
281 ▲

Works Manager.—A Controlled

Firm, with extensive works in North of Ireland, REQUIRES the SERVICES of an energetic man as WORKS MANAGER. Must have good all-round practical knowledge of Engineering, and be familiar with modern factory methods, able to control men, and willing to put in full workmen's hours. A live man will receive every encouragement, in return for which good results will be expected.—State age, qualifications, full particulars of experience, and salary expected to 247, "The Engineer" Office. No person presently employed on Government work will be engaged.
247 ▲

Chief Engineer Required for

large Aero Engine Works, London district; 2000 hands employed. Salary, £1000 p.a.—Address, stating experience to, 243, "The Engineer" Office.
243 ▲

A Firm of Engineers and Steel

Founders can OFFER a good POST to really first-class business man with thorough knowledge of modern systems of Works, Sales, and General Office Organisation. Preference will be given to one with experience in the engineering or motor trade.—Write, stating qualifications and salary required, to Box 5910, c.o. A. J. Wilson and Co., Ltd., 154, Clerkenwell-road, London, E.C. 1.
228 ▲

Assistant Engineer, Experienced

in Blast-furnace and Steel Works Plant, WANTED for Steel Works in South Wales under Government control. Must be 6 o'clock a.m. man, ineligible for military service, and not already engaged on Government work.—Apply, stating age, qualifications, and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3439.
202 ▲

Chief Rate Fixer Required by

Firm manufacturing Internal Combustion Engines and Motor Cars; must be capable of laying out Processes, fixing Rates, and estimating to Drawings on approved modern methods; good organiser essential; take entire charge Department. Only men of tried experience, strong character, and possessed of considerable tact need apply. Excellent prospects and generous salary for right man.—Address, 182, "The Engineer" Office.
182 ▲

Competent Electrician Required

to take charge of Works Power Plant, composed of two 100 K.W. sets driven by 150 B.H.P. oil engines. The works are Government controlled, and the berth will be a permanent one for suitable man. No person already on Government work will be engaged.—Apply, stating age, experience, and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3465.
265 ▲

First-class Experienced Esti-

MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15.
15 ▲

Gas Engines and Suction Plant.

—WANTED, ASSISTANT to Engineer-in-Charge. Must be competent to carry out Running Repairs. Good position to capable, trustworthy man.—Write, stating age, experience, and wages required, 188, "The Engineer" Office.
188 ▲

Good Sewerage and Water Engi-

NEER WANTED to take charge of a number of Installations. Good man will be liberally dealt with.—State full particulars of experience, &c., 7051, Williams's Advertisement Offices, Bradford.
284 ▲

Help Wanted.—Works Manager

REQUIRED in Government-controlled works, London district, preferably with electrical experience; must be of proved ability to organise and control all departments on progressive lines, and should have thorough modern machine shop experience. Permanency and prospects to suitable man. All applications will be treated in strictest confidence.—Write fully to 264, "The Engineer" Office.
264 ▲

Inspectors for Modern Engi-

NEERING establishment, West London district, REQUIRED immediately for high-class small repetition work. Must be used to micro and vernier. Skilled fitters or turners preferred. Men at present employed on Government work or residing more than 10 miles away need not apply.—Write, stating age, experience and wages required, to 242, "The Engineer" Office.
242 ▲

Production Engineer and Pro-

GRESS CLERK.—WANTED, a competent MAN accustomed to supervising the progress and rapid production of aeroplane engines in process of manufacture in works employing 1500 hands.—Apply, stating experience and salary, to your nearest Employment Exchange, quoting "The Engineer" and No. A3445. No person already on Government work will be engaged.
207 ▲

Required, a Thoroughly Qualified

MANUFACTURING ENGINEER, to assist in the management and control of 1000 to 1500 hands engaged in the production of aeroplane engines.—Give full particulars of experience and salary required to your nearest Employment Exchange, quoting "The Engineer" and No. A3444. No person already on Government work will be engaged.
206 ▲

Sheet Metal Industry.—Produc-

TION MANAGER REQUIRED for important firm in North-West London district; preference given to one used to Press Work and manufacturing of Light Gauge Metal Articles. Specialities of manufacture aeroplane components, radiators, tanks, &c. Keen man required, good time-keeper and one used to handling men and supervising production. Must have practical knowledge. Tip-top salary to tip-top man. No one engaged on Government work need apply. Applications in writing. All communications will be treated as confidential—GALLAY RADIATOR COMPANY, Ltd., 4-5, Scrubbs-lane, Willesden, N.W. 10.
259 ▲

The Rhondda Engineering and

MINING COMPANY, Limited, Cambrian Buildings, Cardiff, and their affiliated Company, Sheppard and Sons, Ltd., Ironfounders and Engineers, Bridgend, who are engaged upon work of national importance, REQUIRE the services of a competent Engineer to act as COMMERCIAL and GENERAL MANAGER for both concerns.

Applicants must have had commercial and workshop experience, preferably in connection with the sale and manufacture of Colliery Plants, particularly for treatment of coal.

Applications should be addressed to the SECRETARY, the Rhondda Engineering and Mining Co., Ltd., Cambrian Buildings, Cardiff, giving full particulars of age, experience, and salary required, accompanied by testimonials and references.
218 ▲

Experienced Chemist Wanted as

CHIEF ASSISTANT in the Laboratory of a large Steel and Engineering Works.—Address, stating training, experience, qualifications, and salary required, to 274, "The Engineer" Office.
274 ▲

Wanted, Orders for

CONSTRUCTIONAL STEELWORK, TANKS, HOPPERS, ROOF TRUSSES, &c., HEAVY AND LIGHT PLATE WORK, by ENGINEERING FIRM in MIDLANDS.

Address, in first instance, P855, "The Engineer" Office.
P855

Wanted by Government Con-

TROLLED Establishment in N.E. London district, several First-class DRAUGHTSMEN with Automobile experience. No applicant already employed upon Government work can be engaged.—Apply at your nearest Employment Exchange, quoting "The Engineer" and No. A3436.
193 ▲

Wanted, Good Mechanical

DRAUGHTSMAN, with Technical and Shop experience. Good salary. No person already on Government work will be engaged.—Apply your nearest Employment Exchange quoting "The Engineer" and No. A3457.
248 ▲

Wanted Immediately, Draughts-

MAN for General Engineering Works, East Midlands. Must have good knowledge of Machine Design. State fully experience, also age and salary required. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 260.
260 ▲

Wanted, Junior Draughtsman,

accustomed to general lay-out of Machinery and Buildings.—Apply, stating experience and salary required, to D., c.o. Wilts United Dairies, Ltd., Trowbridge.
292 ▲

Wanted, One or Two Draughts-

MEN, with experience in Mechanical and Structural Engineering Work in connection with Layouts for Electric Power Stations.—Particulars of experience, age, salary required, to THE YORKSHIRE ELECTRIC POWER COMPANY, Wellington-road, Dewsbury.
205 ▲

Wanted, Smart Draughtsmen

by London firm of Water-tube Boilermakers. State age, experience and salary required. No person at present employed on War work will be engaged.—Apply to nearest Employment Exchange, mentioning "The Engineer" and number 293.
293 ▲

A Young Draughtsman Re-

QUIRED who has had shop experience; preference given to one accustomed to Piping and General Plant Work. State age, experience and salary required. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 251.
251 ▲

Assistant Draughtsman Wanted

(Stoke district) with first-class Mechanical Experience in Detail Work. Must be well up in Building Construction and capable of supervising erection of work if required. Would suit wounded soldier. Position offers good prospects to qualified person. State age, experience in full, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 303.
303 ▲

Chief Draughtsman.—Wanted,

thoroughly capable MAN, with General Engineering experience; must be good organiser, well up in modern workshop methods, and able to exercise efficient control over about 30 or 40 draughtsmen. Liberal salary to suitable man. No person already employed on Government work will be engaged.—Address, in confidence, stating fully experience, positions held, and age, 192, "The Engineer" Office.
192 ▲

Draughtsman Experienced in

Internal Combustion Engines REQUIRED for Admiralty establishment. Preference given to one having knowledge of Heavy Oil Engines.—State age, salary required, details of previous experience, with approximate periods employed at each firm, and position, to Box No. 1169, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, London, E.C. 4.
191 ▲

Draughtsman, Junior, Mechan-

ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234.
12 ▲

Draughtsman, Mechanical, One

used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390.
124 ▲

Draughtsman or Tracer Wanted,

ineligible for military service. State capabilities and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 257.
257 ▲

Draughtsman Wanted at Once

for Government-controlled establishment. If possible, with some experience of Aeroplane Design.—Applicants to state age, experience and salary required through nearest Employment Exchange. No one on Government work will be engaged. Mention "The Engineer" and number 237.
237 ▲

Draughtsmen Required Immedi-

ATELY for important Admiralty Establishment. Applicants must be neat and quick, also well up in small details. Give full particulars of experience, copies of recent testimonials, state salary required, age, and present salary by letter only to Box No. 1175, c.o. Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C. 4.
258 ▲

Draughtsmen Wanted, Tho-

ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295.
13 ▲

Quantity Draughtsman or Clerk

REQUIRED immediately for Government Controlled Establishment, with knowledge of Engineering Drawings and Practice. Must be over military age or exempt from service. Application to be made through nearest Employment Exchange. No one engaged on Government work will be employed.—State age, experience and salary required, mentioning "The Engineer" and number 235.
235 ▲

PARTNERS
DIRECTORS
BUSINESSES
FACTORIES
for these apply to
WHEATLEY KIRK, PRICE AND CO.,
46, Watling-street, LONDON, E.C.
Albert-square, Manchester.
26, Collingwood-street, Newcastle-on-Tyne. Sp 3008

SMALL ADVERTISEMENTS
SITUATIONS, FOR SALE, &c.,
PAGES II., III., LXXXIV

Numerical Index to Advertisements,
PAGE LXXXIII.

Required for Steelworks Furnace Design and Charging Machinery, several DRAUGHTSMEN. Good salaries to suitable men. No one already on Government work need apply. Reply, stating age, experience and salary required to your nearest Employment Exchange, mentioning "The Engineer" and number 239. 239 A

Drawing-office Order and Material CLERK WANTED. Preference given to one having experience in Locomotive and Light Railway Work, also Estimating (he would be required to deal with all shop orders and material). Only competent, experienced men need apply, and no person already on Government work will be engaged.—State experience, age, and salary required to your nearest Employment Exchange, quoting "The Engineer" and No. A3469. 250 A

Technical Clerks and Draughtsmen ESTIMATORS REQUIRED for Aeroplane Factory in North-West London. Give full particulars, references, and salary required. No one resident more than 10 miles away or at present on Government work will be engaged.—Address 294, "The Engineer" Office. 294 A

A Large Engineering Company have a VACANCY for a first-class FOREMAN PACKER, who must possess an expert knowledge of the best methods of packing and protecting electrical machinery of all descriptions for foreign shipment. Good salary and permanent position to a suitable man. State age and experience. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3442. 205 A

Foreman Engineer Wanted to Take Charge of Seven Boilers, small Electric Light Plant, &c.—Apply, THE CHIEF ENGINEER, Wm. Whiteley, Ltd., Queen's-road, W 2. 267 A

Machine Shop Foreman Required for Government-controlled Establishment. One used to latest machine shop practice; must be good Timekeeper and had experience with Automatics; 6 o'clock job. No one at present on Government work will be engaged.—Apply, stating age, full particulars of experience, and references and salary required, to nearest Employment Exchange, mentioning "The Engineer" and number 283. 283 A

Wanted, a Millwright for Iron Works. Must be a good man, accustomed both to sheet and guide mills.—Apply, BRADLEY BAR and SHEET IRON CO., Ltd., Bilston. 245 A

Chiltern Hills Spring Water CO., AYLESBURY. WANTED, skilled LABOURER for repairing Mains, in Tring district, and to assist in repairs to deep-well pumps, cleaning out boilers and reservoirs; also work general to pumping station. Wages £1 7s. 6d. per week. House, garden and coal provided at Dancers End Station. Applicants must state age and qualifications. 249 A H. A. CALLON, Manager.

Electrical Fitter, with Knowledge of mechanical work and previous experience abroad preferred, REQUIRED for large Gold Mine in West Africa. Three-phase A.C. plant. No man liable for military service, on Government work, or employed by controlled establishment need apply.—Write, stating age, and give full details of experience and copies of testimonials, to "GOLD," c.o. J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 273 A

Wanted, Position as Assistant MANAGER or FOREMAN. Diesel, oil, petrol, or steam turbines. Erecting, fitting, testing preferred. Had extensive all-round experience. Excellent recommendations. Just discharged from Army.—Address, P843, "The Engineer" Office. P843 B

Works and Technical Manager DESIRES ENGAGEMENT, preferably on large war contract; 20 years' experience leading concerns; first-class credentials.—Address, P840, "The Engineer" Office. P840 B

Works Manager and Draughtsman is OPEN to ENGAGEMENT in Engineering works engaged on Class A or higher priority work.—Address, 301, "The Engineer" Office. 301 B

Advertiser (27), 6½ Years' Shops and D.O., 2½ years assistant to C.E., one year buyer, one year technical assistant to manager in aircraft factory, estimating, drawings, quantities, R.A.F., Dec. M. 6 apprs, trained and capable, DESIRES POST; any district.—Address, P848, "The Engineer" Office. P848 B

As Assistant to Engineer or Agent, or in London office of good firm. Advertiser (37) DESIRES POST as above. Well educated man, with 25 years' experience with well-known firms, in shops, drawing-office, and in London offices (both as assistant and in charge). Excellent references, moderate salary.—Address, P847, "The Engineer" Office. P847 B

Assist. Manager (34) Open for ENGAGEMENT. Internal combustion engines, all types and marine. Shops, design, and commercial exp. Admiralty and A.I.D.—Address, P844, "The Engineer" Office. P844 B

Constructional Engineer and MANAGER, shortly to be disengaged, SEEKS APPOINTMENT; 10 years' experience on public works contracts; all branches of constructional works; used to dealing with large numbers of men and all kinds of contractor's machinery. Now employed constructing railways at one of H.M. munition factories (contract shortly terminating).—Address, 299, "The Engineer" Office. 299 B

Empire Trade After the War.—Experienced Sales Engineer going to New Zealand after the war is PREPARED to REPRESENT British Engineering and Allied Trade Firms. Capable of supervising erection and testing of plant. Expenses and commission.—Address, 112, "The Engineer" Office. 112 B

Engineer (Constructional) Disengaged. Calculations, control of D.O., sound commercial experience, heavy and light structures.—Address, P856, "The Engineer" Office. P856 B

Engineer, M.I. Mech. E. (44), 29 years' practical and commercial experience (14 years management), DESIRES CHANGE as GENERAL or WORKS MANAGER or other responsible position. Comprehensive experience. Speciality—mechanical transport. Up-to-date man, with practical knowledge all departments, scientific works organisation, production efficiency, and mass production of high-class repetition work. Accustomed to conducting negotiations at home and abroad. Highest references. At liberty short notice.—Address, in confidence, P834, "The Engineer" Office. P834 B

Engineer.—Manager, M.I.Mech. E., M.I.A.E., DESIRES CHANGE. Works or General Manager. Thoroughly experienced in General Engineering, War Material, Aero and Motor Trade. Accustomed to organising and handling large staffs. Very energetic, good disciplinarian and not afraid of hard work.—Address, P837, "The Engineer" Office. P837 B

Engineer-Manager, Thoroughly experienced in general engineering and instrument work, is open to negotiate with manufacturers engaged on War work for POSITION as WORKS MANAGER.—Address, P852, "The Engineer" Office. P852 B

Engineer (Now Abroad) Seeks MECHANICAL or RAILWAY APPOINTMENT; any part of world; four yrs. G.W.R., Swindon; marine and oil experience; five yrs. rubber, cotton, and tobacco in Tropics. Willing to proceed direct. Free December.—For particulars and testimonials, apply WALKEY, Canopus, Marasion, Cornwall. P794 B

Experienced Works Manager and DRAUGHTSMAN SEEKS APPOINTMENT with firm on Government contracts for Artesian Well Boring or manufacturing Pumping and Water Supply Plants, &c.—Address, 300, "The Engineer" Office. 300 B

Engineer, Works Manager (46), SEEKS CHANGE. Highly educated, draughtsman, costing and correspondence; 20 years' experience as engineer and works manager; used to handling men; supervising for running and repairs to heavy machinery, including steam plant, electric light, and power; used to early hours. Excellent references from all employers.—Address, P842, "The Engineer" Office. P842 B

Gentleman who has Long been in touch with Exporters, Engineers' Stores, &c., will shortly be DISENGAGED. Experienced in steel; bolts and nuts, &c. Moderate remuneration. Highest reference.—L. DEHANE, 96, Maple-road, Penge, London, S.E. 20 P845 B

Mechanical Engineer, 16 Years' experience in General Engineering, Projectiles, and Repetition work, and having held the position as Head Foreman and Departmental Manager with good class firms, SEEKS responsible POSITION. Competent organiser and strict disciplinarian of male and female labour; capable maximum output. Used to controlling large numbers.—Address, P849, "The Engineer" Office. 849 B

Post in Aircraft or Aero Engine Works REQUIRED as Engineer or Designer; 5 years' shop experience; well up in machine and press tools. Good knowledge of aeroplane design and construction.—Address, P846, "The Engineer" Office. P846 B

Reinforced Concrete Engineer Disengaged. Thoroughly experienced in all Calculations and design. First-class commercial experience. Practical up-to-date and most economical methods of construction. Office and site experience.—Address, P857, "The Engineer" Office. P857 B

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To Engineers.—Superintendent Engineer Requires Re-engagement. Supervise erection of all kinds of Structures and Plants. Sound theoretical and commercial experience.—Address, P858, "The Engineer" Office. P858 B

Tool Engineer, Experienced in laying-out operations and organising shops for the production of small interchangeable parts. DESIRES POSITION AS WORKS MANAGER OR CHIEF DESIGNER. Experienced in small arms and aero engine parts. Address, 302, "The Engineer" Office. 302 B

Young Man, Age 23, Three years on staff at important Blast-furnace Ironworks, finishing as assistant to general manager, and works experience, is OPEN to accept SITUATION in a similar capacity.—Full particulars, address P859, "The Engineer" Office. P859 B

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Gas-Coke Ovens and Bye-Product Works. Experienced DRAUGHTSMAN, Clerk of Works, or Contractors' Agent AT LIBERTY.—Address, ENGINEER, 28, Baker-street, N. Brixton, S.W. 9. P854 B

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Engineer, Fitter and Erector. Good record and all-round experience. Admiralty work. Air Compressors, Refrigerators, Outdoor Erecting. North of England preferred. Or Take Charge of Plant. Age 45.—Address, P850, "The Engineer" Office. P850 B

Working Drawings and Designs quickly and neatly prepared for general engineering work, by fully qualified engineers, A.M.I. Mech. E.—Address, P839, "The Engineer" Office. P839 B

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Penningtons, Engineering Tutors Postal Courses in Mechanical Engineering, also A.M.I. C.E., and A.M.I.M.E. Introductory Course in Engineering Mathematics and Mechanics.—254, Oxford-road, Manchester. 2018 I

A London Company of Sound financial standing having large warehouse and a first-class connection amongst merchants (home and export), DESIRE to HEAR from MAKERS of SPECIALITIES usually bought by Tool Factors, Mill Furnishers, and Wholesale Ironmongers, with a view to act in the after-war period as Representatives, or would contract for the whole output, acting as Wholesale Distributing Agents. Advertisers have information a branch in allied European countries, so as to be prepared for the after-war trade. Agency for any country also entertained. All negotiations to be mutually confidential. Address, 6, "The Engineer" Office. 6 D

Wanted.—The Pioneer Electric CO., 22, Churchgate-street, Fort, Bombay (India), DESIRES CONNECTION with DEALERS in SECOND-HAND MACHINERIES—Electric, Boilers, Oil, Steam or Gas Engines, &c. P791 D

AGENCY FOR LATHES.

The Manufacturers of a High-Grade CAPSTAN LATHE, in demand for W.O. and Admiralty work, are open to APPOINT ACTIVE AGENT, with Show-rooms preferred, in chief industrial centre, home and abroad. Liberal terms and generous territorial appointments. Address, 289, "The Engineer" Office. 289 D

Steel and Tools.—Agent Required for Scotland and Ireland by first-class Steel firm.—Address, 55, "The Engineer" Office. 55 D

Directorship Required by an Experienced Civil Engineer having capital and extensive commercial connections. Give full particulars, stating capital required for investment, and amount of fees per annum.—Address, 297, "The Engineer" Office. 297 C

Partnership Required in Constructional Engineering Firm. Advertiser has had long experience of the trade. Small up-to-date Plant for development and with Water and Rail facilities preferred.—Address, P836, "The Engineer" Office. P836 C

Wanted, Boilers, Lancashire, 120 to 150 lbs. w.p., also ECONOMIC 8ft. by 16ft. for 150 lbs. or near.—A. UNDERWOOD 3, Queen-street, E.C. 269 F

Wanted, Drop-forged Crank SHAFTS for High-speed Petrol and Oil Engines from 20 H.P., one, two, and four-cylinder, for after-war proposition.—Will makers please communicate in first instance with 279, "The Engineer" Office? 279 F

Wanted, Generating Set, About 80 B.R.P., comprising Gas Engine, direct-coupled to compound-wound 6-pole generator, suitable for 220-250 volts, D.C.; gas engine to be driven off town gas. Must be in first-class condition and by approved makers.—Send full particulars to 185, "The Engineer" Office. 185 F

Wanted, Large Salvage Centrifugal PUMP, about 12in., oil driven.—Send price, full particulars, to THOS. W. WARD, Ltd., Albion Works, Sheffield. 178 F

Wanted, Second-hand Turbine developing about 15 H.P., 50ft. head, speed 800/1000 revs., governor gear and direct coupling, with or without dynamo.—Address, 256, "The Engineer" Office. 256 F

Wanted, Steam Boiler, Locomotive type preferred. Barrel approximately 10ft. long × 4ft. 6in. dia., suitable 90 to 100lb. working pressure. Send full particulars and price.—THE AVONSIDE ENGINE CO., Ltd., Bristol. 240 F

Wanted, Steam Travelling CRANE, second-hand, in good order, or new, to lift three tons at 16ft. radius; suitable for 4ft. 8½in. gauge.—Address, 119, "The Engineer" Office. 119 F

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.E., Smith's Agency, Ltd., 100, Fleet-street, E.C. 1 F

Profilers Wanted (New or Equal), take about 2ft. 6in. between housings, about 4ft. traverse; also one with two spindles, take about 5ft. to 6ft. between housings, about 8ft. traverse.—DOWNING, 12, Longbridge-road, Birmingham. 131 F

The Chatwood Safe Co., Ltd., Bolton, REQUIRE large quantities of 3ft. MILD STEEL BILLETS 3in. square, cut up into short accurate lengths, under class A certificate. 187 F

20 K.W. Engine and Dynamo WANTED, direct or belt-driven; 100-140 volts, for battery charging; good condition. Give price, particulars, and address for inspection.—EDWARDS and SHAW, Consulting Engineers, 105, Colmore-row, Birmingham. P825 F

Bucket Dredge, Modern Manufacture, for SALE by Debtenure Holders; fitted with 4 cu. ft. buckets; digs 16ft. below water-line, stacks 10ft. above; steel hull of 3in. plates; 90ft. long, 30ft. wide, 5ft. deep; well hole in rear; fitted with suction gas engine; paid expenses on old sands yielding only 4½ oz. tin per cubic yard; easily converted for gold dredge; cost about £11,000; can be seen in England. Price £4000.—Apply, DEW, 8, Laurence Pountney-hill, London, E.C. 59 G

For Hire, Pumps and Well-Boring TOOLS for Contractor's Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London, S.E. Telephone No. 978 Hop. 822 G

For Immediate Sale, Weir Standard type vertical BOILER FEED PUMP, about 8in. cyl., 5½in. water end. Two vertical Cameron double-ram flywheel STEAM PUMPS; rams 4in. dia., 2 3in. belt-driven Gwynne's CENTRIFUGAL PUMPS, with valves. Self-contained Evans' FOUNDRY RATTLER, single geared, belt-driven, renewable bar barrel, 5ft. long by 2½ft. dia. Strong HORIZONTAL ENGINE, 14in. cylinder, double-expansion side valves, governors, throttle, stop valve, mechanical lubricator, hand-rail all round, outer bearing and large sole-plate.—Address, 267, "The Engineer" Office. 267 G

For Sale.—One Belliss high-speed STEAM ENGINE, semi-enclosed, 2 cylinders, 11½in. dia., 7in. stroke, flywheel 13ft., 6in. dia. by 4in. face, bed 3ft. 9in. by 2ft. 7in., height from floor level to cylinder top 4ft. 6in., equal to new.

One VERTICAL COMPOUND HIGH-SPEED STEAM ENGINE, 61 B.H.P., completely enclosed, central valve, forced lubrication, high-pressure cylinder 8in. dia., low-pressure; cylinder 15½in. dia., 6in. stroke, low-pressure fitted with Buckley's Patent Piston Rings, speed 600 R.P.M. One spare crank shaft, splendid condition. Makers, E. Scott and Mountain.

One Storey-Royce two-crank COMPOUND STEAM ENGINE, 6½in. and 11in. cylinders, running at 350 R.P.M., mounted on extended bed-plate, for receiving generator, 7in. stroke.

Two HORIZONTAL THREE-THROW MINING PUMPS, Fraser and Chalmers, 6½in. gun-metal valves, capable of throwing 1000 g.p.m., 660ft. vertical lift, coupled to B.T.H. induction motors, 275 H.P., 182 R.P.M., 500 volts, 50 cycles.

One Sulzer HORIZONTAL THREE-STAGE MINING PUMP, 1500 g.p.m., 660ft. vertical lift, coupled direct to 500 H.P. B.T.H. motor, 1480 R.P.M., 500 volts, 50 cycles, complete with foot and retaining valves, gear driven, liquid starters, resistances, 10 slate panels and cable, complete from panels to motors.

One Croft and Perkins FRICTION CLUTCH, 150 H.P., absolutely new.

One HYDRAULIC RAM, 11ft. 6in. long, 11in. dia., 16in. bore, 7in. copper sheathed ram, 100 lb. working pressure; immediate delivery.

One HORIZONTAL HYDRAULIC THREE-THROW PUMP, 30 cwt. per sq. in., 14in. plungers, 6in. stroke, 4in. shaft, 4ft. pulley, gun-metal necks and guides.

One CORNISH BOILER, 13ft. by 4ft. 6in., all fittings, 60 lb. pressure; immediate delivery.

One 5in. Double-ram Cameron PUMP, and one Single 5in. Double-ram PUMP.

THOS. OXLEY, LTD., SHILOH WORKS, SHEFFIELD. 290 G

For Sale:—

4-ton	ELECTRIC DERRICK 110ft. steel jib.	
3-ton	do.	90ft. do.
3-ton	do.	70ft. do.

For full particulars, address 306, "The Engineer" Office. 306 G

For Sale, Facing and Boring LATHE, by Buckton; 36in. centre, 7ft. geared faceplate, two tool rests, and bed; weight about 12 tons.—WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. 155 G

For Sale:—

One 600 K.W. GENERATING SET, Engines by Bellis and Morcom, Ltd.; cyls. 16½ and 23in. × 42in. stroke. "Parker" Generator, 500 volts D.C. Complete with surface condenser, motor-driven Pumps, &c.

One 125 K.W. Ditto ALTERNATOR by Ferranti, Ltd., 2000 volts, 50 periods. Vertical Cross Compound Engine, 250 H.P., by J. and H. McLaren.

250 H.P. VERTICAL CROSS COMPOUND CONDENSING ENGINE, by J. and H. McLaren, Surface Condenser, Pumps, &c.

MIRRLEES-WATSON CONDENSER, with separator, but without pumps, 30,000 steam per hour, 3000 sq. ft. cooling surface.

PAIR CROSS COMPOUND ENGINES, 600 H.P., 26in. h.p. cyl., 40in. l.p. cyl., 4ft. stroke, Corliss valves to h.p. cyl., slide valve to l.p. cyl., fly-wheel 20ft. dia., by Barclay, Sons and Co., Ltd.

CROSS COMPOUND HORIZONTAL ENGINE, 14in. h.p. cyl., 22½in. l.p. cyl., 36in. stroke, 12ft. dia. fly-wheel, by Davy, Paxman and Co.

WORM-GEARED CAPSTAN, 5½in. dia. cyls. by 8in. stroke, link-reversing motion, worm geared 30 to 1, drum 2ft. by 1ft. 6in. wide.

MORTAR MILL, under driven, 6ft. dia. pan, engine 7in. × 12in.

R. H. LONGBOTHAM & CO., Ltd., WAKEFIELD, & AT MILBURN HOUSE, NEWCASTLE-ON-TYNE. Tel.: 44 Wakefield; 867 Newcastle. Tel. Add.: "Engineer, Wakefield." 2017 G

For Sale:—

Two Bailey's Belt-driven VACUUM PUMPS, each with 4½in cyl. and 9in. stroke, and air receiver, 23ft. by 2ft. 6in. dia.

Two Baker OIL FILTERS each 9ft. high by 7ft. 3in. dia., ½in thick.

Nine Small Belt-driven Reavell's AIR COMPRESSORS; capacity, 4 cubic feet each.

30 Tons Steel Flanged STEAM and WATER PIPING, from 2½in. to 18in. bore, including Bends and other Specials.

GEO. COHEN, SONS AND CO., 600, Commercial-road, London, E. 14. 2012 G

For Sale, Blowers, 7in. and 5in. All with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1703 G

For Sale, Boilers (2), Galloway Type, 20ft. by 6ft. 6in., 80 lb. w.p.; also Economic, 9 by 14, 100 lb. w.p., with steam dome.—A. UNDERWOOD, 3, Queen-street, E.C. 296 G

For Sale, Engine, Horizontal, Davey-Paxman, 12 nominal horse, cylinders 12in. by 16in. stroke; in good condition.—A. UNDERWOOD 3, Queen-street, E.C. 270 G

For Sale, Air Compressor, 1000 cu. ft. per minute; 2-stage vertical compound, Steam Engine, by Brotherhood, immediate delivery.—A. UNDERWOOD, 3, Queen-street, E.C. 307 G

For Sale, Horizontal Boring MILL, by Wilkinson; geared boring head, 12ft. boring bar, cast iron bed-plates; approximate weight 8 tons.—WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. 156 G

For Sale, Lancashire Dynamo, Double-ended Booster; 675 r.p.m.; each end 370 amps. 30 volts, with regulators and motor starter. Price £300. Purchaser to remove from site.—TRAFFORD POWER CO., Ltd., Trafford Park, Manchester. 161 G

For Sale, Motor Generator, by G.E.C., 500 volts, 225 amps., 650 r.p.m., shunt wound, with two Boosters, series wound, 110 volts, 400 amps., six-pole machines. Seen running in London. Immediate delivery.—WILLIAMS and SONS, South Bermondsey Rly. Station, London, S.E. 16. 154 G

For Sale, One Belliss and Morcom Two-stage AIR COMPRESSOR, 1500ft. per minute to 90 lb., direct-coupled to 200 B.H.P. motor; A.C., 3-phase, 50 periods, 400 volts. Been running about twelve months; delivery can be made in about one month.

One "Sentinel" AIR COMPRESSOR, 500ft. per minute to 80 lb.; 327 r.p.m.; complete with base plate, fly-wheel, and accessories. This compressor is perfectly new, and delivery can be given immediately.

Apply, PYEWOOD COLLIERY CO., Ltd., Darton, Barnsley 252 G

For Sale, One Musgrave Engine, Horizontal Tandem Compound, drop piston valve; cylinders H.P. 15in., L.P. 29in. diameter, 2ft. 6in. stroke. Flywheel 12in. diameter, 16 ropes 1¼in., external barring teeth and barring engine complete.—Apply, D. and R. DUKE, Darlington. 254 G

For Sale, One New 30-Brake H.P. Marshall GAS ENGINE with Suction Producer Plant (no cooling tanks or piping). Price and particulars from MARSHALL, SONS and CO., Ltd., Engineers, Gainsborough. 148 G

For Sale, One Triple Expansion 2200 I.H.P. non-condensing marine type Standard BELLISS ENGINE, 200 lb. steam pressure, 500 degrees Fahrenheit superheat, 200 r.p.m., complete with steam stop valve, 27in. Blakeborough atmospheric exhaust valve, Bruce valve, Parker oil separator and exhaust pipes direct coupled to one 1400 K.W. three-phase alternator, 6000 volts, 50 period, with separate 200 volts direct-driven exciter on alternator shaft, complete with exciter, series and shunt rheostats, and exciter switchgear. The whole plant is in perfect working order, the alternator having been entirely rewound two years ago. Can be seen at any time at the Generating Station of the Central Electric Supply Company, Limited, Grove-road, N.W.—For terms, apply THE SECRETARY, Central Electric Supply Company, Limited, 19, Carnaby-street, W. 1. 274 G

For Sale or Hire, Electric MOTORS, from 6 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-Street, London, E.C. Tel.: City 3936. 2025 G

For Sale, Plate Shearing Machine, 9in., 8ft. blades; engine driven.—Address, 262, "The Engineer" Office. 262 G

For Sale, Portable 16 N.H.P. RUSTON-PROCTOR, 80 lb. w.p.; in good condition.—A. UNDERWOOD, 3, Queen-street, E.C. 295 G

For Sale, Steel Box Girders; about 200 tons; 20ft. to 35ft.—Apply, 6, Whitechapel-road, London, E. 1. 308 G

For Sale, 3-Throw Motor-driven AIR PUMP, Edwards type, capacity 30,000 lb. steam per hour, 480-530 volts; seen fixed.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 296 G

THE TASMANIAN GREAT LAKE HYDRO-ELECTRIC POWER SCHEME.

THE Tasmanian Government's Great Lake hydro-electric power scheme had its origin in 1908, when a Melbourne company—Complex Ores, Limited—approached the authorities with a view to obtaining permission to harness some of the States' water power so as to make it available for the electrolytic treatment of complex zinc ores, by the Gillies patents, owned by the company. A concession was granted in 1909, and a separate undertaking—the Hydro-electric Power and Metallurgical Company, Limited—was formed to carry out the necessary works. This company, owing, we believe, to lack of sufficient capital, eventually disposed of the concessions to the State on certain terms. In coming to a decision to make this purchase, the Tasmanian Government and Parliament were influenced to a large extent by a report by Mr. Evan Parry, chief electrical engineer of the New Zealand Government, who strongly advised that the step should be taken. The Government, having acted on this advice, engaged the services of Mr. J. H. Butters, who had been the engineer in chief of the Hydro-electric Power and Metallurgical Company, and, as such, had been responsible for the design and carrying out of the works from their inception. Mr. Butters was made chief engineer and general manager of the new undertaking, and the Government created a new department—the Hydro-electric Department—for the purpose of completing the scheme and operating it after its completion.

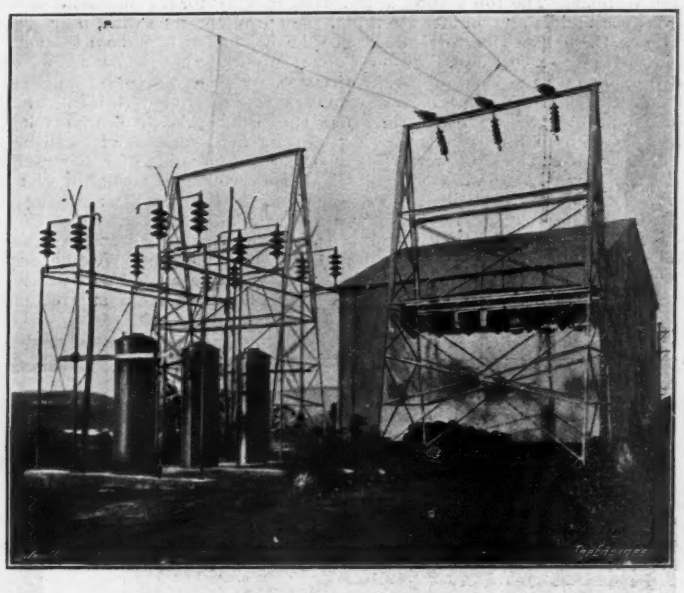
The physical nature of the country in which the water power is developed is peculiarly suited for the purpose. Two rivers, the Ouse and the Shannon, play important parts in the scheme. The Shannon has its origin in the Great Lake, a large body of water originally covering an area of some 42 square miles, but now increased in extent, as we shall see later, and situated at an elevation of 3250ft. above sea-level. It drains a catchment basin of some 227 square miles, which has a heavy rainfall and snowfall ranging from 60in. per annum upwards. The lake, it may be mentioned, is very nearly in the centre of the island.

Between two and three miles westward from the Great Lake, the river Ouse has its source in what are known as the ninety-nine lagoons, the level of which is considerably—we believe about 200ft.—above that of the lake. In any case, the level is so much higher that the water from the lagoons can readily be diverted into the lake, so as further to augment the supply of water available from the latter. The diversion will, we believe, be a simple and inexpensive operation.

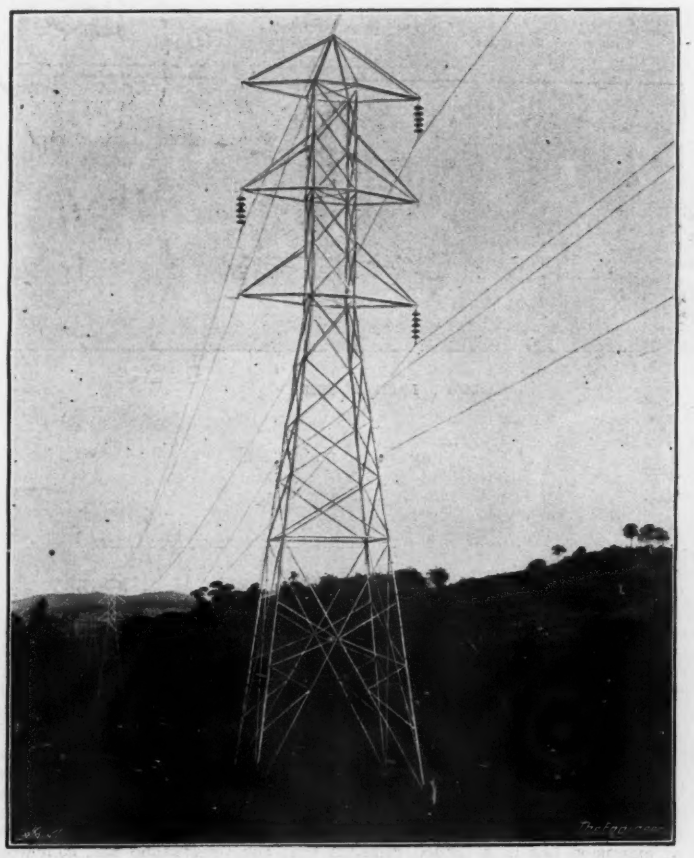
Now, although the Ouse rises at a higher altitude than the Shannon, and although at a point some twenty miles south of the Great Lake the two rivers actually join one another, they by no means have the same gradients throughout their lengths. In fact, some five miles south of the Great Lake the Ouse is actually about 1300ft. below the Shannon, and only a few miles away from it across country. It is this combination of circumstances which has rendered the Great Lake scheme not only possible, but notable.

By means of a dam, built at the south end of the Great Lake, an additional depth of 11ft. of water was obtained, and the area of the reservoir, thus formed, increased to 50 square miles. This increase in depth represents, by itself, a storage of over 15,000 million gallons of water. About five miles down the Shannon a diversion weir has been constructed which turns the water into a canal some 3½ miles long, and varying in width from 22ft. to 75ft., and in depth from 16ft. to 4ft. Along this channel the water flows into a large lagoon or storage reservoir formed by the building of three low dams and having an area of some

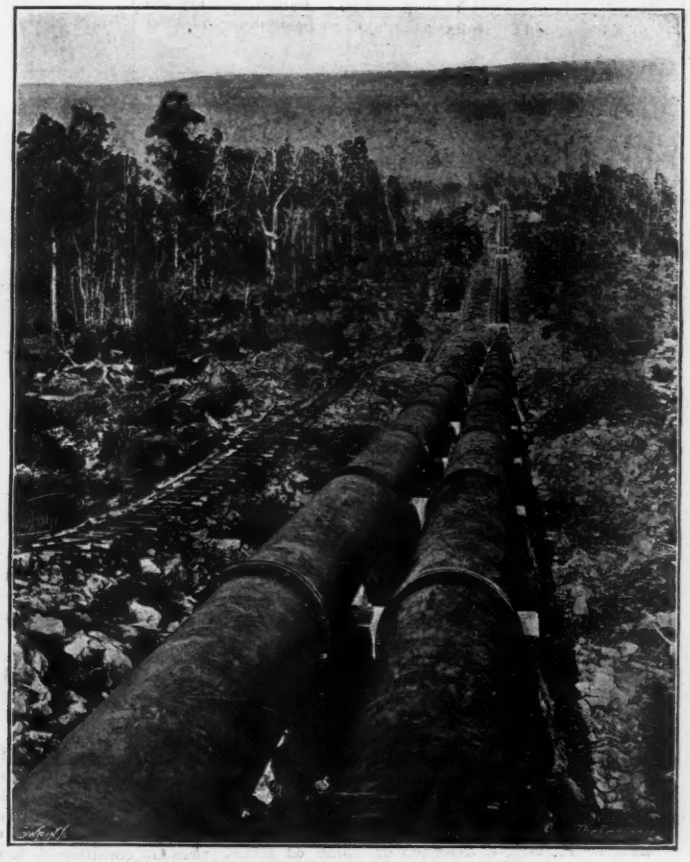
POWER-HOUSE AND STEEL PIPE LINE



STEP-DOWN STATION WITH LIGHTNING ARRESTERS



VIEW ALONG THE TRANSMISSION LINE



PART OF THE STEEL PIPE LINE

380 acres. This large body of water, from which the supply for the power-house is immediately drawn, is a valuable feature in the scheme.

Starting from a penstock chamber, formed in this reservoir, is a wood-stave pipe 4ft. in diameter and 5660ft. long. At its lower end this pipe is connected by a breeches piece to two steel pipe lines which lead down to the power-house, situated on the bank of the Ouse, into which the water, when it has done its work in the turbines, is discharged. Each of the steel pipe lines is some 4220ft. long, and is divided into three sections. The top section is 3ft. 1½in. in diameter, the middle section 2ft. 9½in., and the bottom section 2ft. 5½in. The total difference in height between the reservoir and the power-house is such as to admit of a net head of 1015ft. of water. The pipes are held by anchor blocks at points where differences in gradient occur, and are supported every 20ft. by masonry piers. They are further secured by thrust blocks between the anchor blocks.

In the power-house were originally installed two main three-phase turbo-alternators, each of 3500 kilovolt-ampères capacity. These were driven by two turbines of the Pelton wheel type, made by Boving and Co., each having a normal output of 4900 brake horse-power, when supplied with water having the net head mentioned above. The alternators are of the 50-cycle 16-pole rotating field type, designed for a normal speed of 375 revolutions per minute. They are separately excited by turbine-driven generators, the latter being 6-pole shunt wound machines designed to produce direct current at from 110 to 120 volts, which, in addition to being used for excitation purposes, is also employed for lighting the station, and for operating the various accessories. The normal output of each exciter turbine is 180 brake horse-power. The turbo-alternators and exciter sets, as well as the switchgear and crane, were supplied by the British Westinghouse and Manufacturing Company, Limited, as chief contractors.

Electrical energy is generated at 6600 volts by the main generators, and this pressure is stepped up by means of transformers to 88,000 for delivery to the transmission lines. By reason of the central position of the power-house, it would be possible to transmit energy to any point on the island. At present it is only sent to Hobart, a distance of some 64 miles. Before proceeding to describe the transmission line and the receiving station, we may say that, to begin with, the main turbine house was so designed as to be capable of containing eventually units up to as large as 10,000 kilowatts in size, and provision was also made for rail access right under the main crane through sliding doors. The iron and steel buildings were supplied and erected by the contractors, the brickwork and concrete work up to the ground level being done by the workmen of the company. The buildings were specially planned so as to allow of further extensions, and the sections were calculated to withstand horizontal wind pressures up to 40 lb. per square foot. The overhead crane has a main lift of 30 tons and an auxiliary lift of 5 tons. It is equipped with two 15 horse-power motors, one for lifting and the other for longitudinal travel, and with a 6 horse-power motor for cross travelling. The speed of lifting the 30-ton load is 5ft. per minute, while the 5-ton load can be lifted at 28ft. per minute.

The standards for carrying the transmission lines consist of lattice girder masts. They are designed for six conductor wires, three on each side. To commence with, only three stranded copper cables, each with a cross section of .05 square inch, were laid. The normal span between the towers is 600ft. The minimum clearance between the cables and the ground is 18ft. There are in addition two No. 14 S.W.G. bronze telephone wires, the clearance in the case of these being 12ft. An earth wire, consisting of 7/10 stranded steel cable, is carried on the highest point of the masts from end to end of the line. From the receiving house current is distributed at 6600 volts to various sub-stations in Hobart.

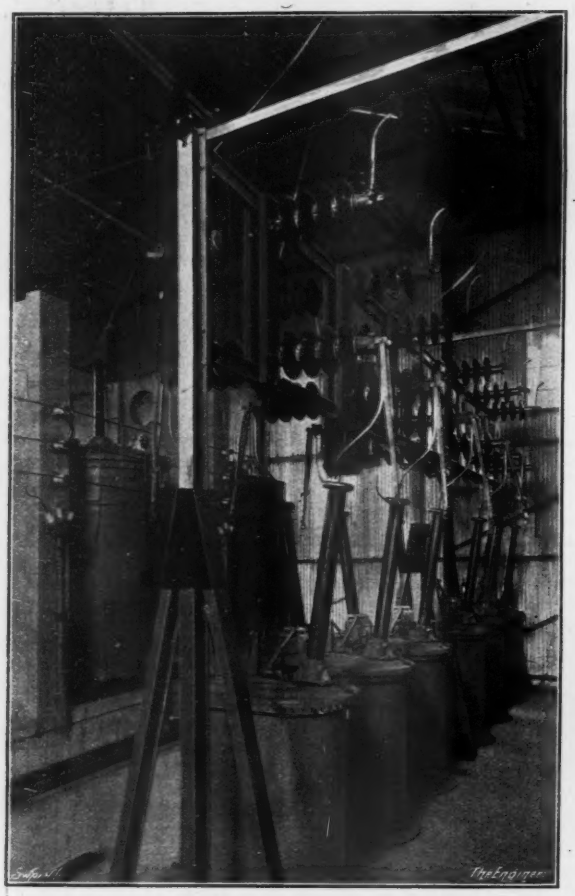
The transformers at the generating station are of the Westinghouse Company's three-phase oil insulated and water-cooled type. The high-tension sides are star connected and the low tension, or generator, sides are connected in mesh. The step-down transformers at the Hobart receiving station are of a similar type, with the 6600-volt windings in mesh, and the high-tension side in star connection. Both the transmission line and the receiving station with its switchgear, &c., were, like the main plant, supplied by the Westinghouse Company.

The inaugural ceremony for the entire Great Lake scheme took place in 1916, when the Governor of Tasmania, Sir W. G. Ellison-Macartney, opened the first sluice. At the opening of the power-house the Governor-General of Australia, Sir Ronald Crauford Munro-Ferguson, performed the ceremony, and started the station turbines.

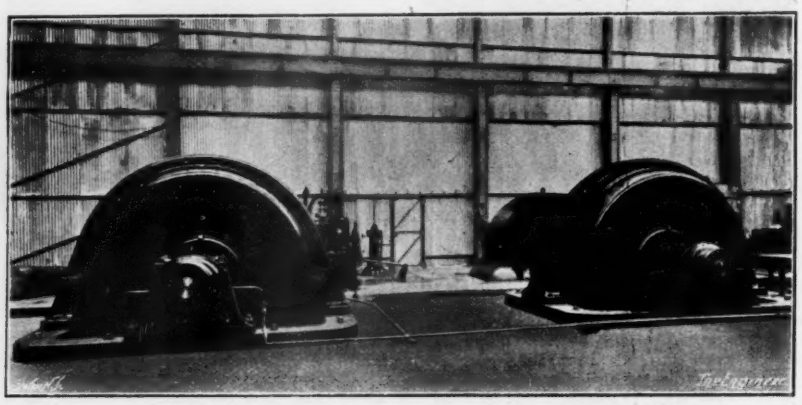
We are enabled to give herewith, on page 78, and in our Supplement, numerous engravings, reproduced from photographs, showing the hydraulic as well as the electrical portions of the equipment.

So great a success has attended the operations of the undertaking that already, and notwithstanding present conditions, the work of extension has been commenced. The Australian Wood Pipe Company is to lay a 60in. wood-stave pipe alongside the existing 48in. pipe. The remainder of the hydraulic equipment is to be supplied by Boving and Co., Limited. The upper portion of the steel pipes, which is 2300ft. in length, and in which the head varies from 150ft. to some 380ft., will be of riveted steel, 55in. in diameter. The plates of these will be bent, drilled and scarfed before shipment, so that the work of laying will consist almost entirely of riveting. The remainder of the line, some 2100ft. in length, is to consist of lap-welded pipes, with high-pressure muff joints, similar to those in the existing pipe lines. This section is in two portions, 49in. and 45in. in diameter respectively, so that the pipes may be nested for shipment. The maximum thickness of metal at the lower end is to be 1in. This pipe line is to be connected up to the existing line by a common bus pipe, so that any of the turbines may be fed from any one of the pipe-lines, sluice valves being provided for sectionalising the pipes if required.

A new generating unit, consisting of an 8000 horse-power Boving Pelton wheel turbine provided with two jets operating on a single wheel, and coupled to a 7000 kilovolt-ampère three-phase generator, by the Australian General Electric Company, is to be erected. It may be pointed out that the new pipe line would be able to supply, probably, twice the power required to drive the new unit; but it has been made large enough to provide for extensions, which it is confidently anticipated will be required in the near future. The additional transformers required in the power-house, together with those which will be required in one of the sub-stations, are to be supplied by the Westinghouse Company, while the equipment for a 4000 kilovolt-ampère outdoor sub-station at North-West Bay, is to be provided by the Australian General Electric Company. This sub-station is, we understand, to supply current for the manufacture of calcium carbide as well as for the treatment of zinc ores.



88,000-VOLT SWITCHES IN STEP-DOWN STATION



500-H.P. TURBO-ALTERNATORS

AUXILIARY EXCITER SETS

SOCIETY OF CHEMICAL INDUSTRY.

No. I.

THE annual general meeting of the Society of Chemical Industry was held in Birmingham on July 18th, 19th, 20th, and as was the case in 1915 and 1916 it took the form of a chemical congress at which papers on chemical technology were read and discussed, the entertainments and social gatherings which characterised the pre-war meetings being altogether suppressed. There was a very good attendance from all parts of the United Kingdom, the bill of fare provided by the activities of the local section being evidently appreciated. Indeed, here and there one heard remarks that the programme was somewhat overloaded, and that those who sat through the business meetings had little opportunity for that interchange of ideas among their fellows which has always been an enjoyable and withal important feature of the annual meetings.

The report of the Council showed the Society to be in a flourishing condition both as regards members and financially the number of members now on the register is 4393, as compared with 4059 last year, the considerable number of members elected during the past year largely exceeding the inevitable losses.

The report dealt with the various activities of the Council in connection with war developments, and with schemes for extending the scope and usefulness of the Society. Steps are being taken for the formation of a Bristol and South Wales section of the Society; consideration is being given to a proposal for the formation of a Section of the Society in India, and there is also the possibility of the formation of a Canadian Pacific Section as an addition to the existing Canadian Section. A proposal to increase the annual subscription from 25s. to 30s. and the life composition fee by £5 was carried *nem. con.* Professor Henry Louis, of Newcastle-on-Tyne, was elected president for the ensuing year in succession to Dr. C. C. Carpenter, of London, who has held the office for two years.

PRESIDENTIAL ADDRESS.

Dr. Carpenter, in his presidential address, which succeeded a cordial welcome to the Society from the Lord Mayor of Birmingham—Alderman Brooke—said they had met in a city renowned as being essentially material and practical in its character. If the connection of it with Priestley was not so close as that of Watt they might remember that it was here he suffered martyrdom for his opinions. If they sought the basis upon which the structure of modern industry had been erected they would find it largely in the science of mechanics and of chemistry. The mechanical engineer would not be likely to dispute the influence of Watt, nor would the analytical chemist be likely to deny indebtedness to Priestley. It was true our present-day vision of the future was not quite the same as that which illuminated the minds of these two great men. But the steam engine the one designed was just as essential an adjunct of the modern power plant as was the chemistry practised by the other to the modern synthesiser of new substances. With the future of the Empire was closely bound up progress in applied science, and of a certainty chemical science; and that progress was impossible of achievement without the complete and sympathetic collaboration of both chemist and engineer. The progress of the chemical industry required the inspiration of the chemist in all and every direction, but he urged that the greatest advantage should be taken of the engineer's particular gifts to bring about its achievement, once he was made to understand the conditions to be aimed at. Going on to speak at some length of the importance of science education, the President urged that the first principles of experimental science should be taught in all primary schools. The ignorance of even the language of science among not only what were called the working classes, but the governing classes, also was appalling, and the only remedy was in universal teaching. The nation could not be expected to appreciate science at its true value unless that appreciation was inculcated as thoroughly as patriotism. The importance of the chemical industries and national progress was at last becoming understood, and must be taken into account in the refashioning of our educational system.

Leaving education, the President said an essential change was needed in our knowledge of the raw material resources of the Empire. It should be the duty of the State to map out all our mineral resources so that they might be placed at the disposal of industry by and under the control of the State. He could not picture a future in which it was possible to work our mines only having regard to the present, or in which anything but a surplus output went abroad before home requirements were satisfied. It should be an offence to supply coking coal for ships' bunkers even though the price paid was a good one. The State must consider whether it was better to export coal for steel making by our competitors, or to send them the finished article, but if we sent our raw materials abroad their sale should be made a matter of inter-State exchange and barter. It ought to be possible to make a beginning by exporting coke instead of coal, and thus increase our control of by-products, the need for which was rapidly increasing. By this means we should work up the nitrogen content of our own coal and export that instead of the mineral, which should be recognised as the property, as it was the heritage of the nation.

SILICA.

Owing to reasons which hardly need explaining we shall only be able to deal with the many interesting and important papers read at the Congress in a cursory manner. The first session was occupied with silica. Owing to the absence of the author, Professor Fearnsides' paper on "Some Problems Presented by Silica Bricks" was not presented. A paper by Professor Boswell on "Sands used in Metallurgical Practice Compared with those used in Glass Manufacture," was read, in the author's unavoidable absence, by a substitute. He wrote the increase in the output of glass of all kinds, and the largely increased output of metals and alloys resulting from the demands of munitions of war, had necessitated the investigation and utilisation of British resources of sand to a much greater extent than heretofore. Before the war unnecessarily large supplies of foreign sands were imported into this country, particularly for lining the hearths of furnaces for steel, and for making the best qualities of glass, but except in the case of one or two foreign supplies of sand it had always been clear that the country could be self-supporting in that connection. When peace conditions once more reigned economic consideration would be the determining factor which would say whether we should use our native supplies or unnecessarily jeopardise the safety of a key industry by still being dependent upon sea-borne material. Reference was made to the fact that the Birmingham district was famous for its deposits of red moulding sand which had been sent to many distant parts of the world. An important part of the paper dealt with the connection between the chemical and mechanical constitution of sands. Steel founders had long said that bulk analyses of moulding sands with a natural bond were practically useless. Valuable information could, however, be obtained from a chemical analysis, and in general it was desirable to have three types of analyses of clays, sands and crushed rock materials used in commerce, viz., chemical, mechanical and mineralogical. The glass sands of the United Kingdom had been thoroughly investigated under the auspices of the Ministry of Munitions, and the question of home supplies of refractory sands, especially those used in the steel industry, was even more urgent, and much preliminary research work into the properties of such sands was required before all the suitable supplies could be located.

In another paper, by Mr. Walter C. Hancock, entitled "Some Observations on the Texture of Fire-clays," it was pointed out that the texture of raw or unburnt clay was quite different from that of the same material after firing, and that there was no simple method of determining the texture of the latter, as could be done of the former, by disintegrating with water. Experiments had been made on a typical Stourbridge fire-clay, and the methods employed in the analytical investigation formed the main part of the paper. In the discussion the President said that he had been struck with the difference in the procedure in foreign factories and in ours. With us the clay was mixed with some grog, and that was the end of it. The German idea was different. The Germans built up their clay from material proved by investigation to be satisfactory. This resulted in a product better than the British. Though we were doing more, we were still not up to the grade of refractories produced by Germany.

A paper by Mr. Henry Watkins, of Burslem, dealt with "Chemical Porcelain." Speaking of the future prospects of the trade, the author pointed out that the English potters for the last two years had supplied Great Britain with nearly all that had been needed for scientific work, as also for chemical processes connected with the war. The cry, therefore, that it could not be done was no longer admissible. We might not at present have succeeded in making anything superior to the German production, but he ventured to prophesy that in much less time than chemical hard paste porcelain had been manufactured, this country would be making something superior. The aim of the English potter therefore should be not to copy slavishly the hard paste porcelain, but rather to produce his own particular type of porcelain which would fulfil all requirements demanded of it. There was no very tempting offer, he said, of any lucrative opening in the new business, and a potter must be more moved by patriotism to his country, and a desire to meet its needs, than by immediate prospective financial success.

BENZENE AND TOLUENE.

Mr. T. F. E. Rhead, of the Birmingham Gas Department, contributed a paper on "Some Sources of Benzene and Toluene for High Explosives," in which, after reviewing the subject generally, he said that when the urgent demand for toluene and then benzene had to be met, the Ministry of Munitions took the logical course of increasing the supply from the existing sources and then of investigating and encouraging possible new sources. Prior to the war the gas and tar from coke oven recovery plants, and a small proportion of gasworks tar, supplied us with all the benzene and toluene we required, and much was sent to Germany in part payment for the German recovery plants set up in this country. A large and little known field of supply was town's gas, which often contained thirty to forty times the amount found in tar. In the years immediately preceding the war, the high price of petrol had focussed attention on benzol as a possible substitute, and several people had advocated washing it out of town's gas. The American engineer Doherty had urged the possibility in this country of recovering 2½ gallons per ton of coal carbonised for gas manufacture, but our antiquated illuminating power standard prevented that procedure. The war demand put a new aspect on the problem, and a large and increasing proportion of town's gas was now being washed for these valuable products. Toluene was also being obtained as a natural constituent of crude petroleum, but the high paraffin content was a drawback. A good deal of experimental work had been done in processes intended to increase the benzol content of coal gas, and a series of results obtained by Mr. E. W. Smith at the Birmingham Gasworks were given. The effect of carbonising coal with coal-tar pitch, Mond gas pitch, petroleum residue, and bitumen in horizontal gas retorts was tried, and it was found that all of them, with the exception of coal-tar pitch, materially increased the benzene content. The subject of the cracking of petroleum oils for benzene and toluene was also dealt with, the author pointing out that in Russia it had long been the practice to crack petroleum oils to obtain benzene and other aromatics for the dye and explosive industries, Russian petroleums being rich in naphthenes lending themselves admirably to benzene formation. At the present time much work on this subject was being done in America. The manufacture of carburetted water gas was essentially an oil cracking process, and the evidence so far available went to show that a good quality benzene and toluene could be obtained by washing the gas from this process.

THE FUTURE OF CANADIAN RAILWAYS.

WE have now received a copy of the blue-book, printed by order of the Dominion Parliament, containing the majority report of Sir Henry Drayton and Mr. W. M. Acworth, and the minority report of Mr. A. H. Smith, as to the present and future status of the railways of Canada. It may be remembered that Sir George Paish was originally a member of this Commission, but he had to resign owing to ill-health, and his place was taken by Mr. Acworth. The latter is, of course, the well-known railway economist, whilst Sir Henry Drayton is the chairman of the Board of Railway Commissioners of Canada, and Mr. Smith is the president of the New York Central system.

Till within the last decade Canada was, omitting the Intercolonial and other small undertakings of only local interest, served by two main systems. They were: (1) The Canadian Pacific, stretching right across the continent, and having access to all important points, both in the East and in the West, with control also of a considerable mileage in the United States, and in a very prosperous financial position. (2) The Grand Trunk—whose original charter dates from 1851—with a strong hold on Eastern Canada, and also with important United States connections. The Grand Trunk had always met its obligations, though over a series of years the return to its shareholders had been but small. Westward, the Grand Trunk only extends, in Canada, as far as Lake Huron. But even ten years ago the Canadian Northern, which had started as a local line in Manitoba in 1896, was beginning to build up in the Prairie provinces a system which, in 1906, comprised more than 2400 miles, and which now contains over 5000 miles in these provinces. It had grown rapidly with the growth of the Western country, and had always earned sufficient net revenue to take care of its obligations.

The Canadian Pacific had, it will be seen, the advantage of gathering its own traffic for itself and of keeping it in its own hand throughout. The other two companies were in a different position. The Canadian Northern had to depend for west-bound rail traffic on what the companies in the East, one of which was a rival, handed to it. On the traffic which it collected in the West, it lost the long haul to the East. It was not unnatural that the company should reach out to the East. For the same reason it was equally natural that the Grand Trunk Company should reach out to the West. And public sentiment, which felt that the growth of the country justified and required more than one transcontinental line, undoubtedly sympathised with the company's ambition.

In these circumstances each company set out independently to construct into the territory of the other, and a very large measure of Government help was given to them.

In fairness to the Grand Trunk it should be observed, however, that the responsibility for the construction of the line from Moncton to Winnipeg, now known as the National Transcontinental, does not primarily rest upon the company. It proposed to go only as far as North Bay, and it was Government action which was responsible for the line being carried eastwards all the way to Quebec. The further prolongation from Quebec to Moncton was added during the passage of the Bill through Parliament, the cost of the work proving a great deal more than specified. The Grand Trunk Pacific Company refused to carry out the bargain, and the Government, by accepting its refusal, and commencing to work the line itself, released the company unconditionally. Hence, the National Transcontinental is now part of the Government railways. The western portion of the line was built by the Grand Trunk, but having got rid of the eastern end, it is now willing for the Government to take over the western end on certain conditions, and desires to revert to its old position of a local road in Eastern Canada. To both courses the Commission is opposed.

In the judgment of the Commissioners it is not in the interests of Canada that the operation of its railways should be in the hands of the Government. They know of no country in the world where a democratic State owns and operates its railways, in which politics have not injuriously affected the management of the railways, and the railways have not had an injurious influence on politics. They do not think Government ownership of the Canadian railways would tend to reductions of rates but rather in the contrary direction.

Sir Henry Drayton and Mr. Acworth think that if the State took over and undertook to operate the Grand Trunk, the Grand Trunk Pacific and the

Canadian Northern, it would be morally bound to offer to purchase the Canadian Pacific also; but that company is in a strong financial position and does not ask to be purchased or to be helped in any way.

Moreover, Canadian railway companies own, lease, or control no less than 7000 miles of railway in the United States, and the effect of Government ownership would be that the Canadian Government might be ordered by the Inter-state Commerce Commission to alter its rates, which is not a situation that would conduce to international harmony.

The majority holds that in normal conditions railway enterprise is a matter best left in private hands, subject to proper regulation by the Government. And it therefore recommends (1) that a board of trustees be constituted by Act of Parliament, and incorporated as "The Dominion Railway Company." (2) That the ownership of the Canadian Northern, Grand Trunk, and Grand Trunk Pacific Railways be vested in this company. (3) That the Government assume responsibility to the company for the interest on the existing securities of these undertakings. (4) That the Intercolonial, including the Prince Edward Island and National Transcontinental Railways be also handed over by the Government to the company; and (5) that the whole of these railways, be operated by the company as one united system. The trustees are to be five in number. We need not repeat the recommendations as to their qualifications, but should note that it is recommended that one should be selected as "specially possessing the confidence of railway employees." The Board is to be non-political, permanent, and self-perpetuating. The present Board of Railway Commissioners is to have the same control over the new company that it has over the private railway companies.

The estimated annual liability of the Government to meet interest unearned during the first few years of the scheme is put at about 12,500,000 dols. This amount should diminish steadily but not slowly. With proper economic and politically undisturbed management the attainment of a satisfactory financial result is only a question of time. The enlargement of the functions of the Board of Railway Commissioners so that it has jurisdiction over all Dominion railways is recommended. Railway Councils, as in Germany, should be established to bring together the railway management and representatives of public interests. It is shown that the cost of hauling grain to the station is sometimes as great as the carriage from the station to Liverpool, and it is recommended that the question of highway improvement and motor haulage be taken into consideration. The future expenditure on the Hudson Bay Railway should be reduced to the lowest possible limits. Finally, stress is laid on the necessity for immediate action lest Canada should suffer from railway congestion even worse than that of the past winter.

Mr. A. H. Smith, who presents a minority report, is the president of the New York Central system. His suggestions are: (1) Amend the regulating policy so that the Railway Commission shall have jurisdiction over all railroads in the matter of maximum and minimum rates, the insurance of securities, the building of new railroads, or the extension of existing lines, and other matters properly within the scope of governmental supervision. (2) Create a board of trustees, consisting of two Government officials and three private citizens, to act for the Government in the matters hereafter proposed. (3) Relieve the Grand Trunk Railway Company of its obligation to lease the Transcontinental, and require the company to relinquish all claims upon the Transcontinental; require it to lease to the board of trustees the Grand Trunk Pacific Railway properties at a rental amounting to the net annual fixed charges; require it also to take under lease the Canadian Northern properties east of North Bay and Parry Sound, and pay as a rental the net fixed charges on these properties. The time for the lease should be for twenty-one years. The Grand Trunk investments, other than railroad, in the West, may be disposed of by the company as it may elect, and in accordance with its best interests. (4) Require the Canadian Northern to confine its operations to the field west of Winnipeg. Relieve it of the line east of Winnipeg by leasing for twenty-one years to the governmental board of trustees, at a rental of the annual fixed charges. Require it to take a lease of, and to operate for the same period, the Grand Trunk Pacific Railway and its branch lines, paying as rental the net annual fixed charges on these properties; except that until seven years after the end of the war they shall have the immunity that was promised the Grand Trunk Pacific for a period of seven years after construction, and that they shall not be required to assume any of the extraneous investments of the Grand Trunk system in the West. (5) Lease the lines between North Bay and Winnipeg, except the Canadian Pacifics, for a term of twenty-one years to either the Canadian Northern or the Grand Trunk, or, in the event neither applies, to any other qualified company, requiring the lessee to furnish the necessary capital for new equipment, and to maintain and operate the lines on the best terms that can be made; terms that would give the best service needed at the lowest cost to the Government being regarded as the best. Either the Government or the lessee should build a connecting line of about thirty miles near Long Lake, Ontario, to ensure the better working of the two lines. (6) The Government and companies should have the option of terminating, after ten years, any of the leases upon equitable terms.

Mr. Smith proceeds to say that the foregoing recommendations are made with a view to obtaining for Canada a maximum of efficiency at a minimum of cost. The continuance of Government aid, to some of the railroads at least, will be necessary under any plan. The plan herein proposed seeks to reduce this to the lowest possible point, and to centralise it upon those parts of the existing lines that are not self-supporting, and which, in the nature of things, cannot be self-supporting for years.

"Facing," he says in conclusion of this report, "the urgency of the need, considering the part which the Government has taken and the responsibility it shares, and keenly alive to the magnitude and importance of the tasks now placed upon the railroads, and the greater tasks they will face, I see no safe alternative but the Government shall continue, with discrimination and resort to all available safeguards, and under a policy of proper regulation and co-operation of effort, to aid the necessitous railroads of the Dominion until such time, which I hope and believe will not be far distant, when these will become self-supporting and the problem will be solved."

ADVISORY COMMITTEE FOR AERONAUTICS.

THE report of the Advisory Committee for Aeronautics for the year 1916-17 was issued on Friday of last week. Following the rule of the immediately preceding years, it omits the technical appendices which in peace time were the principal and most interesting parts of the reports. The Committee is now constituted as follows:—The Right Hon. Lord Rayleigh, O.M., F.R.S. (President), Dr. R. T. Glazebrook, C.B., F.R.S. (Chairman), Dr. Dugald Clerk, F.R.S., Mr. Horace Darwin, F.R.S., Sir E. H. Tennyson d'Eyncourt, K.C.B., Mr. Henry Fowler, A.M. Inst. C.E., M.I.M.E., Sir G. Greenhill, F.R.S., Lieut.-General Sir D. Henderson, K.C.B., D.S.O., Mr. F. W. Lanchester, M. Inst. C.E., Mr. H. R. A. Mallock, F.R.S., Lieut.-Colonel Mervyn O'Gorman, C.B., Commodore Godfrey Paine, C.B., M.V.O., R.N., Professor J. E. Petavel, F.R.S., Brigadier-General D. Pitcher, Sir Napier Shaw, F.R.S. Secretary, Mr. F. J. Selby.

The report is appended:—

The experimental investigations carried out under the control of the Advisory Committee for Aeronautics into the many problems affecting the development of aircraft have been continued and extended during the past year.

Owing to the growth of the work of the Committee in certain directions, sub-committees have been formed to advise in regard to special matters. An Internal Combustion Engine Sub-committee has been appointed under the chairmanship of Dr. Dugald Clerk: Mr. Fowler is acting as chairman of a Light Alloys Sub-committee. Other sub-committees have been constituted from time to time to investigate particular problems.

Many changes and developments in the design and construction of aircraft have taken place as the result of the continued and varied experience gained from their use in warfare under modern conditions. An increasing number of special problems is thus constantly presented for investigation, and these have very closely occupied throughout the year the attention of the staffs engaged in experimental work both at the National Physical Laboratory and at the Royal Aircraft Factory. In addition to aerodynamical research, much attention has been given to questions relating to engines, materials of construction, strength of construction and design, instruments and accessories, as well as to methods of attack from aircraft, and other matters.

Equipment for Experimental Work at the National Physical Laboratory.—Reference was made in the report for last year to the additional equipment provided for experimental work. The wind channels now available comprise two 7ft. channels, two 4ft. and one 3ft. The new 7ft. channel was completed and brought into use early in the year 1916-17. No important departure has been made in its design from that of the earlier 7ft. channel, but some minor modifications have been introduced which experience had indicated as tending to greater convenience in working. An air speed of 85ft. per second can be reached in this channel with an expenditure of 160 horse-power. It is doubtful whether further increase in size of channel or in speed of air current would advance existing knowledge to an extent sufficient to outweigh the greatly increased cost and other disadvantages involved. If it should prove necessary, for certain purposes, to conduct experiments on a larger scale and at higher speeds, it would appear, therefore, to be necessary to employ a method in which the model is moved through the air. As is well known, this procedure presents various difficulties, and the securing of even moderately accurate data in this manner is, at the best, extremely laborious. Probably the least troublesome way of applying this method is by installing measuring apparatus on the aeroplane itself, and it seems probable that only in this way can an accurate comparison be obtained between model and full scale conditions. The matter is of importance, and attention is being given, so far as existing circumstances permit, to the devising of suitable measuring apparatus.

Improved methods of supporting the models under test in the channel have been devised for use in special cases. The effect on the measure resistance of the method of holding the model is often surprisingly large, and without the necessary care and experience in avoiding effects due to interference with the air flow, very large errors may result. The difficulty is of course in general greatest in measurements on forms of small head resistance, *e.g.*, aeroplane bodies and airship envelopes. Earlier measurements on airship models of stream-line shape were made to determine the form of least resistance, and were, in the main, comparative: from the cause mentioned, it is probable that little reliance can be placed on the absolute values then obtained. With the new methods of support the possible error has been greatly reduced, and when full scale values have been determined with accuracy, the prediction of full scale resistance from the model experiments will be established on a satisfactory basis. The new method of support is employed also in tests of models of complete aeroplanes.

Experimental Work in Aerodynamics.—It is not proposed at present to enter in detail into consideration of questions on which experiment has been in progress. Fliers and designers have, of course, given close attention to matters in which improvement would be of value, and this has led to the repetition and re-examination, from a somewhat modified aspect, of many earlier investigations. The experiments have been of very varied character, and have included tests of models of, probably, all types of aircraft at present employed. A large part of the work has arisen from specific inquiries proceeding from the service departments, but progress has been made with some investigations of more general character.

A number of experiments have been carried out relative to the resistance of airship shapes, and further observations on the distribution of pressure in such cases have been made.

The investigation into the stability of the aeroplane has been continued. A number of special cases have been examined, and results of importance have been reached. The theory of airship stability has also been investigated.

Research into the nature of the flow of fluids round obstacles has been continued.

A number of investigations relating to airscrews have been carried out, with a view to increasing the accuracy of prediction of performance, and thus facilitating the design of airscrews for special purposes. Tests on screws to be used as windmills for the production of power have also been made.

The work has included a complete series of tests on more than one complete aeroplane model. The information thus derived is of considerable importance for practica purposes in aeroplane design.

Strength of Construction.—A number of questions relating to strength of construction have been investigated, and some general conclusions have been reached tending to simplification of strength calculations. The basis to be adopted in design to secure adequate strength in high speed machines, with the power of rapid manœuvring essential in aerial fighting, is a matter demanding the most careful consideration. To secure the highest possible speed it is necessary to keep down the weight to a minimum, and the best compromise between these two opposed conditions does not admit of precise determination. This question has received attention, and the manner in which strength varies with increase of dimensions has also been made the subject of investigation. Cases in which vibration has been set up have been examined, and calculations relating to the strength of the body structure have been made.

Engines.—A number of questions relating to engines and engine design have been submitted by the Air Board for consideration by the Engine Sub-committee. These have required very careful investigation, and the sub-committee has been closely occupied since its formation with the various problems which have arisen. Experimental work has been carried out, by request of the sub-committee, at the Royal Aircraft Factory; and the sub-committee has received much assistance in the examination of special questions both from the Royal Aircraft Factory and from manufacturing firms whose works have been visited.

An extensive series of experiments on radiators has been carried out at the National Physical Laboratory, and other investigations relative to the transfer of heat from surfaces to fluids flowing over them are in progress. These have an immediate bearing on the design of the cooling systems in aeroplane engines. Experiments relating to the performance and efficiency of magnetos have also been made.

Light Alloys.—The use of light alloys in the construction of aircraft and aircraft engines is becoming of rapidly increasing importance, and improvements in the production of light alloys will have great effect on future development. The investigations relating to light alloys which have been in progress for many years at the National Physical Laboratory have been continued, and results of special interest have been achieved during the past year. Suggestions have been made to the Air Board by the Committee which may, it is hoped, help to secure the best conditions in manufacture for the development of such alloys. The formation of the Light Alloys Sub-committee will be of great assistance in co-ordinating the work on light alloys which is being done in various quarters, and in collecting the information resulting from experimental investigation and manufacturing experience. Experimental work has been carried out for the sub-committee at the Royal Aircraft Factory, the University of Birmingham, the National Physical Laboratory, and elsewhere, and arrangements have been made for placing the information obtained at the disposal of manufacturers.

Fabrics, Dopes, &c.—A number of special questions have arisen for investigation in relation to airship and aeroplane fabrics. A large amount of attention has been given to materials for use as dopes, varnishes, &c., and the laboratory has collaborated with the Military Air Department in an investigation into the behaviour of fabrics, dopes, and protective coatings under the conditions of tropical exposure. The results of exposure to ultra-violet radiation have been studied in relation to the effect of sunlight, and conclusions of importance have been reached. The Committee is indebted to Dr. Shakespear, of the University of Birmingham, for information he has placed before them as to the methods developed by him for determining the permeability of fabrics by hydrogen; comparisons have been made with the results obtained at the National Physical Laboratory. Methods of determining the purity of hydrogen have been investigated.

Investigations Relating to Seaplanes.—Tests on models of seaplane floats in the William Froude National Tank have been continued and extended. The provision made last year for an increase in the staff available for carrying out this work has enabled more rapid advance to be made, and a number of important questions have received attention. The methods employed have been improved and elaborated, and new apparatus has been designed whereby additional measurements can be obtained and further

information secured relative to special conditions arising in practice.

Special Matters.—As usual, a large number of special questions have been referred to the Committee for advice or investigation. The experiments relating to bombs have been continued, and valuable communications relative to the flight of bombs have been received from the Air Department of the Admiralty and from the Central Flying School. The Committee is indebted to Professor Karl Pearson, F.R.S., for communicating to them the results of his calculations of bomb trajectories. This question has also been the subject of investigation at the National Physical Laboratory.

Questions relating to the attack of aircraft from aircraft have been examined. Problems in connection with the aeroplane compass have been further considered. Other instruments and apparatus for use on aircraft have been investigated.

As previously, a number of inquiries have been received from the Board of Invention and Research and the Munitions Inventions Department, and investigations have been carried out at their request at the National Physical Laboratory and at the Royal Aircraft Factory.

Reports from the Experimental Stations of the Air Services.—A number of communications have been received during the year relating to experimental work carried out by the R.N.A.S., and by the testing squadron of the Royal Flying Corps. Many of these have been of great interest and value, and of much assistance in the application of the results obtained from the model experiments and in the estimation of aeroplane performance.

The Committee visited on various occasions during the year military and naval air stations, as well as the Royal Aircraft Factory and the National Physical Laboratory, and witnessed many interesting experiments and trial flights.

Experimental Work at the Royal Aircraft Factory.

Engine Experiments.—Much research has been made into various methods for improving the output and the reliability of aeroplane engines. A large number of radiators of various types have been tested, and an efficient type has been standardised. Great progress has been made in the development of the air-cooled engine. Work has been done on the compensation of carburetters for variation of air density and a device for improving the performance of engines at great heights has been tested on several engines.

Full Scale Aeroplane Experiments.—The measurement of the resistance of aeroplanes in flight has been continued with the object of confirming the model experiments, and an instrument for measuring the resistance directly has been developed. The distribution of air pressure over the surface of the wing of an aeroplane in flight has been measured and further experiments on these lines are in progress. Experiments have been made on longitudinal and lateral stability of aeroplanes in flight, and much theoretical work on the same subjects has been done. Measurements have also been made of the disturbance of the air behind a propeller to obtain data which are required in the design of new machines.

Instruments.—The behaviour of various types of magnetic compass in an aeroplane in flight has been investigated. Two new types of bombsight have been developed, and are now being tested. The improvement of the standard aeroplane instruments has been continued, and a number of special instruments have been devised for use in connection with full scale experiments on aeroplanes. The means of communication between pilot and observer have been improved.

Fabrics, Dope, &c.—Weathering tests on fabrics and experiments on the influence of humidity on their strength have been made. The development of a calendered fabric has received attention. The deteriorating effect of various agents (bacteria, light, &c.) has formed the subject of considerable research. The experiments on the composition of dopes, varnishes, and pigments and on fluxes, paints, and oils have been continued.

Light Alloys.—Much experimental work has been done to arrive at the most suitable aluminium alloys for engine parts. Experiments have also been carried out in the application of the alloys which have been developed at the National Physical Laboratory.

Meteorological Work.

Experimental work in meteorology has been mainly in connection with the inquiry into the location of distant thunderstorms and the tracing of their progress across the map by means of a properly organised system of observations at various stations.

In this inquiry valuable assistance has been rendered by various officers of the Admiralty, Royal Engineers and Royal Flying Corps. The Meteorological Office Observatories at Richmond and Benson have also been in co-operation, and apparatus has been lent by Professor Peddie, of University College, Dundee.

A portable hut has been installed for the accommodation of the assistant, close to the receiving station.

On some occasions the progression of thunderstorms across the map has been satisfactorily identified, although the identification on other occasions was uncertain.

Further attention is necessary in order to develop an apparatus which is more directly suitable for the purpose than that which is at present in use, in consequence of the variability of the sensitiveness, which, with the present form of apparatus, is unavoidable.

In addition, an inquiry into the variation of the gustiness of wind between day and night has been provided for by the erection of an anemometer with its vane at 140ft. above the ground; and for the purpose of this inquiry Captain Cave, R.E., officer in charge, has lent two thermographs in order to determine the corresponding variation in the temperature of the air.

Observations have also been made of the variation of the wind with height close to the ground; and a large number of observations of pilot-balloons have been made and duly reported.

THE output of aluminium from the works at Foyers and Kinlochleven, in Scotland, is now well over 10,000 tons per year.

CONCRETE ROADS.*

What has been Done in America.

DOES it not seem rather remarkable that, whereas in the United States and Canada many millions of square yards of unprotected concrete roads have been constructed during the last ten years, very few attempts have been made in this country to follow this example?† It is hard to believe that such a shrewd business people as the Americans would have invested millions of dollars in such roads unless they felt confident of their success.

It is true that the "English" engineer is said to be more cautious than his American cousin, but this is not a sufficient reason for him to show timidity where progress can, and should be, made, or otherwise no advances, for the benefit of mankind, would be forthcoming.

It is not suggested that the use of concrete, as a road material, should take the place of other materials, but that this description of road construction might be included in the practice of road building, and should be given a better chance in the future, than it has received in the past, to prove, or disprove, its merits.

Opinions of American Engineers.

It was stated by Mr. Stern, the Chief Engineer of Highways of Manhattan, New York, that with regard to a concrete highway it answered "all the essentials of a thoroughly first-class pavement at the lowest cost. Its adaptability both for horse and motor vehicles in all kinds of weather, for twelve months in the year, its smooth surface and comparative noiselessness, coupled with its extremely low total annual cost, compared with any other type of pavement, would appear to guarantee for it a very wide use throughout this country."‡

Such testimony from an engineer of Mr. Stern's eminence cannot be ignored, especially as he gives in his paper—which he read at the Congress—details of the first cost, and subsequent cost of maintenance, of nine different types of road construction, showing that concrete roads were considerably cheaper in the long run than any other form of construction. It may, of course, be contended that Portland cement is much cheaper in America than in England, but even when this is taken into account the low cost of maintenance of a well-constructed concrete road brings the ultimate cost down below many other forms of construction, the initial cost of which may have been less.

At the International Road Congress held in London in 1913, Mr. A. N. Johnson, the State Engineer to the Illinois Highway Commission, gave a paper on "Concrete Road Construction," in which he stated: "The possibilities of this form of construction, together with the very promising results obtained in the past few years, make it worth the study and investigation of highway engineers."

In 1914 a very representative meeting of engineers was held in Chicago, at which a large number of papers were read on the subject of concrete roads, and the general opinions there expressed were unanimously in favour of such a method of construction. The movement in favour of concrete roads in America is supported by the Government, the State Boards, the Municipal Boards, by many of the Universities, and, as has already been stated, by most of the leading engineers of the country.

Reasons why Concrete Roads should Prove a Success.

In face of this consensus of opinion, it is idle to dismiss the possibilities of concrete roads, or to contend that the movement in this direction is merely due to the anxiety of Portland cement manufacturers to sell their goods.

Nor can the contention hold good that the climatic conditions of the United States make it possible successfully to construct concrete roads, whereas in our country the climate is against such a form of construction, when we find that in Sioux City, Iowa, U.S.A., there are upwards of a million square yards of concrete roads, some of which have been down more than six years, and where they were laid under very trying climatic conditions, the temperature ranging between 35 deg. Fah. *below* zero up to 115 deg. Fah., and where there are frequently terrific rainstorms. The roads are universally 6in. in thickness, not reinforced, the concrete consisting of one of cement, three of sand, and five of broken stones. The traffic is stated to be "very heavy" in some of these streets, and it is on record that there are no cracks or settlements in any one of the carriage-ways constructed of concrete. This excellent result is attributed to "very careful workmanship," careful selection of the materials, and proper mixing. It is claimed that these roads are not slippery, though some of them are laid on gradients as steep as 1 in 9. It appears from a careful study of the American practice that these good results have not been obtained without a very careful study of the question; numerous tests and trials have been made of materials, and also as to the behaviour of concrete under varying conditions, whilst many conferences have been held by engineers to discuss questions of the right methods to be adopted. These questions appear, *inter alia*, to be the right proportions of the materials, the consistency of the wet concrete, the size and description of the aggregate, the strength of the aggregate, the proportions of the different sizes of the aggregate, the proportion of water to be used, the reasons for surface cracking, the amount and effect of expansion and contraction, the amount of friction between the slab and the sub-base, the best methods for mixing the concrete and placing it *in situ*, the finish of the surface, the organisation of the labour employed, and many other details.

Mr. Boulnois then proceeded to give some particulars regarding the materials employed in American practice, the method of mixing, &c.

What has been Done in England and Scotland.

It has been stated that concrete roads have been constructed in Leith, near Edinburgh, for the past thirty years, but that they have not been altogether successful, probably because they were not constructed under a "cast iron" specification. About two or three years ago a reinforced concrete road was laid at Chiseldon, near Swindon; it was constructed for military purposes, and was originally intended to have an asphalt surface, but it was left as it was, and has proved satisfactory. A layer of cinders was laid on the sub-base, rolled to a finished thickness of 3in., and the concrete 6in. in thickness was laid thereon.

In the City of Chester, Mr. Matthews Jones, the City Engineer, who is a well-known advocate of concrete roads, has constructed several streets in this manner. The following is a brief description of the methods he employed:—The aggregate is as follows:—1 ton of 2in., 1½ tons of 1½in., 1½ tons of 1in., 1½ tons of ¾in., and 1 ton of ¼in. broken stone, which were thoroughly mixed together, in order to eliminate the voids as much as possible. Where the sub-base is wet or composed of clay, he places at least 2in. of ashes thereon. On this he puts from 2½in. to 3in. of concrete for a length of anything from 25 to 50 lineal yards, the full width of the carriage-way. On this he places his reinforcement, with the stronger bars laid transversely. Then the next layer of concrete, whilst that underneath is still fresh. The surface is then finished with the flat side of the spade: no floating is done. He keeps the surface ¼in. higher than the finished contour to allow for shrinkage. Each length of concrete is finished against a board laid across the street, which board is removed as the other length of concrete is put in. This gives an upright finish, and also acts as a transverse expansion joint. The traffic is kept off for three weeks, and the surface is kept well watered. Finally, the surface is tar-sprayed and covered with ¼in. granite chippings.

The results have been extremely satisfactory, though it is fair to state that these roads are not subjected to a very heavy traffic, only about 60 tons a day, which reduced to the usual standard gives about 3000 tons per yard width per annum.

In Dunfermline, Scotland, a concrete road was constructed last year—1916. It was 15ft. 6in. between the kerbs, and not subject to heavy traffic. It was laid 6in. in thickness and reinforced. After the sub-base, or foundation, had been properly prepared, 2in. of concrete was laid, and on this was spread the wire reinforcement, which was covered with another 2in. of concrete, whilst a final 2in. finishing coat of concrete was laid on this. The lower layers were not allowed to set before the other layers were laid on them. The two bottom layers consisted of one cement, two sharp sand, three broken whinstone—1½in. gauge. The finishing coat consisted of one cement, two ¼in. granite chips and dust, two whinstone chips—½in. to 1in. gauge. When the surface was about "three parts set" it was gone over lightly with a bass broom—thus securing a "key" for the tar-spray—and was kept covered with sand, which was kept moist for seven days, and was removed at the end of fourteen days. The surface was then tar-sprayed and "chipped" with whinstone chippings—⅜in. to ¼in. gauge. No transverse expansion joints were provided, but ¼in. white pine boards were laid against the kerbs, which boards were intended to be afterwards removed so as to provide expansion joints, but there was difficulty in getting them out and consequently they were left in.

The Kent Concrete Road Trial.

By far the most interesting experiment in the construction of concrete roads in this country was that on a portion of a road near Gravesend, in Kent, which was commenced in the late autumn of 1914.

This road is not a success, and with the exception of one portion of it which was constructed in a different manner to that laid down by the specification, it became pitted and flakey, and broke up badly. The reasons for this failure are many, but the chief causes appear to be that in the first case the concrete was too weak, which is confirmed by the fact that the portion referred to above as having been constructed in a different manner to that which failed was constructed with the same aggregate, but in the proportions of one of cement to three of aggregate.* The traffic in the road is about 1000 tons a day, consisting chiefly of motor omnibuses and quick-running commercial motors of great weight. The carriage-way is only 21ft. in width.

After discussing "Points to be Considered in Constructing a Concrete Road," and "Suggestions for the Preparation of Specifications for Concrete Roads," Mr. Boulnois concludes as follows:—There is no doubt that the future traffic on our roads and streets will become more and more intense in weight, speed and quantity, and the roads of the future will be expected to carry this traffic.

It will be the duty of all highway engineers carefully to consider the best manner in which to meet these greater demands on the strength and durability of our roads, and possibly it will be found that properly constructed concrete roads may, in some cases, meet the requirements.

I have purposely said very little as to the benefits of reinforcement, as this question must be left to the engineer who designs the construction of a road. There can be no doubt that reinforcement, properly applied, has revolutionised concrete construction, and where very heavy weights are to be carried by a road, or where there is an unstable sub-base, it might be found desirable to insert some form of reinforcement, but each case must be considered on its merits.

This report is merely intended as a short statement of what has been attempted in connection with concrete roads, and also to act as a guide to those who are contemplating the construction of a concrete road, or street, without any surface protection.

AT the recent annual general meeting of the Association of Private Owners of Railway Rolling Stock, reference was made to the watchful care constantly necessary for safeguarding the rights and interests of members of the Association, and to the Committee's endeavours to assist in dealing with the difficulties in such a manner as to avoid recourse being had to any such dangerous experiment as the general pooling of privately-owned wagons.

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* Abstract of Report to The Roads Improvement Association, Incorporated, by Mr. H. P. Boulnois, M. Inst. C.E.

† During the year 1914 alone, it was estimated that no less than 17,000,000 square yards of concrete roads were constructed in America, and that at the present time there must be at least 50,000,000 square yards of such roads in the United States.

‡ *Vide* "Proceedings" of "Second National Conference on Concrete Road-Building," held at Chicago, February, 1916.

* The main portion of the concrete was made of six parts of crushed ballast and sand to one part of Portland cement. The full specification is given in the Report.

ELECTRIC DISCHARGE AND CROP PRODUCTION.

ALTHOUGH the application of electricity to crop and plant growth is one of the oldest branches of electrical science, the earliest experiments going back to the eighteenth century, it is only within a comparatively recent period that any systematic attention has been given to the subject, and definite progress made with the accumulation of knowledge which should prove a guide to the agriculturist in making application of electrical methods to stimulate crop and plant growth. Even now, although work on a scientific plan has been in progress in various parts of the United Kingdom for some time past, it cannot be said that much definite knowledge is yet available as to the manner in which the electric discharge acts upon growing crops, nor is it possible to state the best method of utilising the electric current or the kind of crops to which this aid to growth can be most usefully applied. However, the numerous experiments which

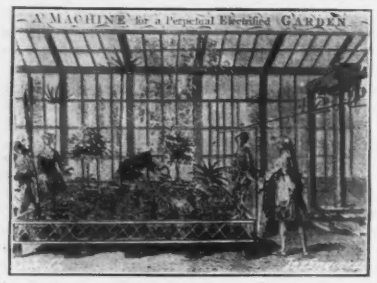

Fig. 1—EARLY TESTS OF THE ELECTRIFICATION OF CROPS

are now either in progress or in contemplation at Pershore, Lincluden, near Dumfries, in Ireland, at Evesham, Bristol, Hereford, Chester and Wisley, and in some of which the Botany Department of the Imperial College of Science, representing the Board of Agriculture, is interested, promise to yield information which should determine some of the several disputed points as to type of apparatus, and the various other questions which await solution. It is fortunate that, to a certain extent, the work is being co-ordinated, and that any unnecessary distinction between the scientific side of the work and its commercial applications is being bridged. It is essential if real progress is to be made, that the whole of these important experiments should be carried out under one direction, so that overlapping may be avoided, and the work be planned on lines which will enable the results to be collated and made available to all who are interested in the subject.

As already indicated, the early experiments go back to the eighteenth century. One of the original workers was a Scotsman, who subjected myrtles to a discharge from a frictional machine, and was led to the conclusion that it acted as a stimulus to growth.

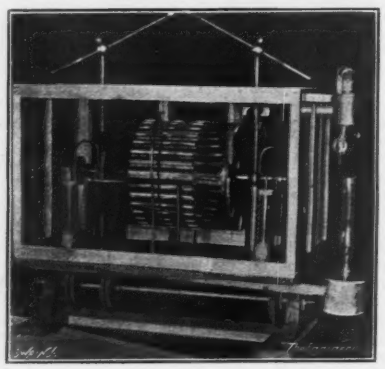

Fig. 2—LEMSTROM'S INFLUENCE-MACHINE

More elaborate experiments are to be credited to the Abbé Nollet. There were also the experiments of the Abbé Berthelon, who dabbled with the question in 1783. At a later date experiments were put in hand in France by Professor Berthelot at the station for Agricultural Chemistry established at Meudon. The effect of silent discharge was then tried, and the theory was put forward that the clue to the advantage of employing an electric discharge was the influence of atmospheric nitrogen on the plant metabolism. A print of an early apparatus of electrifying plant is shown in Fig. 1. There are indeed many records of work which has been carried out in this country and on the Continent, but the modern development of the subject dates from the practical experiments which the late Professor Lemstrom, the Swedish scientist, commenced in the year 1885. Whilst travelling in the Arctic Circle, Professor Lemstrom was impressed by the remarkable development of vegetation in Polar as compared with more southern regions, and he was led to attribute this to the large amount of electricity present in the air at that part of the earth, an impression which was strengthened by the fact that experimental reproductions of the Aurora Borealis in his own greenhouse appeared to have an extraordinary influence on plant growth. The experiments on a larger scale which Professor Lemstrom subsequently carried out in Finland, in Burgundy, in Germany, and at Durham University gave positive demonstration that the application of electric discharge had a marked effect on the yield of various crops. All the common vegetables and cereals, as well as strawberries and raspberries, were the subject of experiment. Professor Lemstrom's method was to erect a wire network consisting of fine iron wires spaced at intervals of 4ft. at a height of 16in. above the ground, the height being increased as the crops grew. The wires were provided with points something like those on barbed wire, and the network was charged by an influence machine—see Fig. 2—of Professor Lemstrom's own design.

At the meeting of the British Association in 1898 Mr. E. H. Cook described some experiments he had conducted with the discharge from the negative pole of a Wimshurst machine. These tests aimed at the direct utilisation of atmospheric electricity. Experiments were also made by Baron Adelsvard in Sweden in 1902 and 1903, and at Breslau in 1902. Dr. H. G. Dorser has made tests in America, employing a Tesla alternating discharge with apparently good effect. Demonstration was then given that the electricity must be applied to the aerial portion of the plant and not to the soil. There are also data available on the negative side, Grandeau having demonstrated that plants protected from atmospheric electricity had their development greatly retarded.

Lemstrom was certainly the pioneer of the modern school, and his type of apparatus was used by early experimenters in Great Britain and elsewhere, but doubts have been expressed by some of the workers in ihis field, notably by Mr. J. E. Newman, who carried out some experiments on the Lemstrom plan at some nursery gardens at Bitton, Bristol, in 1905, whether the apparatus as originally designed did in every case succeed in ionising the air to an effective extent. It is suggested, indeed, that leakage over the insulation on damp days would, in some of the larger scale trials, have absorbed the small amount of current generated. Mr. Newman did succeed in Bristol in obtaining results which suggested that the application of electricity was one which should be further investigated, but he reached the conclusion that the influence machine was quite unsuitable for the work, It was obvious, too, that the close network of wires near the ground would interfere with essential farming operations. A well-known engineer who was attracted by the problem was the late Mr. B. H. Thwaite, and he, it will be recalled, carried out some experiments, chiefly by means of the electric light. Professor J. H. Priestley has done a great deal of work in this field, and in a paper published in 1905 described some of the important results reached. Mr. Ingvar Jorgensen, who is now working in conjunction with Professor V. H. Blackman at the Imperial College, carried out experiments at the Danish Government Agricultural Experimental Station at Copenhagen, and subsequently worked with Professor Priestley, who at that time held an appointment at University College, Bristol, and was afterwards transferred to Leeds University.

Real progress, however, may be said to date from the alliance between Mr. J. E. Newman and Sir Oliver Lodge. Realising that the influence machine was unsuitable for the purpose, Mr. Newman had recourse to Sir Oliver's method of generating high-tension electricity, and it is the Lodge-Newman system which has been employed in most of the recent experimental work down to the present time. The latest type of apparatus is illustrated in Fig. 3. Under this system alternating high-tension current is generated by an induction coil, one terminal of the secondary being connected to earth, and the other to the discharge network through a series of Lodge rectifiers. The apparatus which is now in use has only been evolved through a long process of trial and error. The original set made use of an ordinary X-ray coil with high-tension mercury vapour rectifiers, but both the coil and the rectifiers failed under service conditions. The Lodge valve, which is used in the apparatus at present supplied for agricultural purposes, has been modified in details from time to time, but it remains essentially the same in principle as when it was first introduced, and the latest form may be regarded as reliable.

In the latest type of apparatus for agricultural works two sets of valves are arranged in parallel, the current being distributed to them by a rectifier driven off the shaft of the mercury gas break. The coil is water cooled, and the use of perishable material is avoided, to eliminate as far as possible the risk of breakdown, and with the fact in mind that if electro-culture is to become common practice the installation will frequently have to be handled by those unskilled in the use of electrical apparatus. The ammeter with the primary current which is usually supplied generally shows that 2–3 ampères are used in the primary of the coil, with the sparking distance at the field spark gap, indicating the potential difference between the wire network and earth, between $\frac{1}{2}$in. and $\frac{3}{4}$in. A set of valves will pass enough current to charge a network of from 25 to 30 acres. It may be pointed out that the same type of apparatus has given satisfactory service in fume deposition work, where the conditions of operation are far more severe than in agricultural operation. In recent agricultural installations the supply current is 100–250 volts direct-current, and the working pressure 120,000. Continuous current has been adopted for this work because it resembles the normal atmospheric electrification, and because experience suggests that positive electricity produces better results than negative. There is some evidence, however, that leguminous plants prefer the latter.

A general method of applying the discharge to the area planted is as follows:—Over the area to be electrified is erected a wire network consisting of thin galvanised steel wire, run, preferably, at an average height of 15ft. above ground, in order not to interfere with harvesting operations. The wires, spaced ten

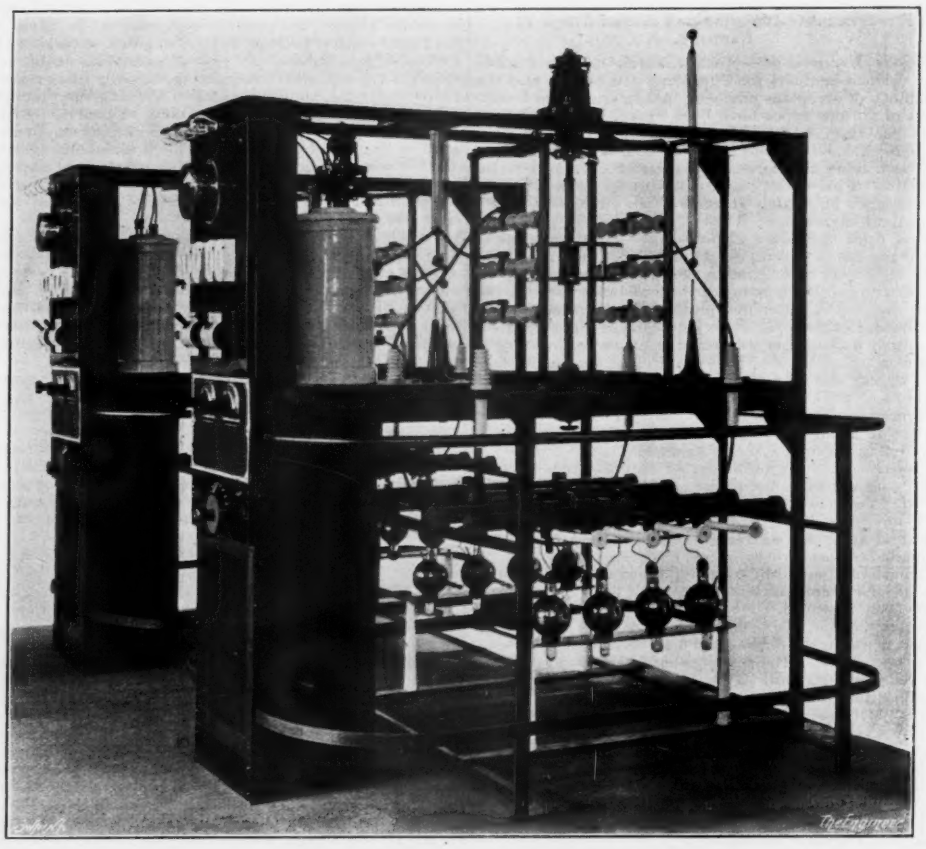

Fig. 3—LODGE-NEWMAN APPARATUS

yards apart, are carried on span wires between stout telegraph wires on insulators mounted on posts planted about 70 yards apart in parallel rows about 100 yards apart. The wires are carried by specially designed insulators, to withstand the high potentials employed. Those over the field are not attached to the main insulators at all, except through ebonite rods or looped porcelain insulators.

Coming to the consideration of the practical work done on the subject during recent years, the two sets of experiments which attract attention are those carried out by Mr. J. E. Newman at Salford Priors,

Fig. 4—APPARATUS AT LINCLUDEN

Evesham, between 1906 and 1911, and the work of Miss E. C. Dudgeon at Lincluden, Dumfries. In the Evesham experiments about 19½ acres were covered with the wire network. The results attained over the series of years appear to be quite conclusive as to the beneficial effect of the electrical discharge on crop growth. It is true that in 1911, a year of drought and prolonged sunshine—conditions altogether against the use of electricity—the results were negative. In 1906 the increased yield from wheat in the electrified area was between 29 and 39 per cent., and from barley 5 per cent. In 1907 the gain in the wheat crop was 29 per cent., or 9.4 bushels per acre; in 1908, when wheat was again planted, 24.3 per cent., or 5 bushels per acre, over a similar crop grown adjacent to the electrified area, were secured. These results were repeated in other years with the exception of 1911. With fruit and vege-

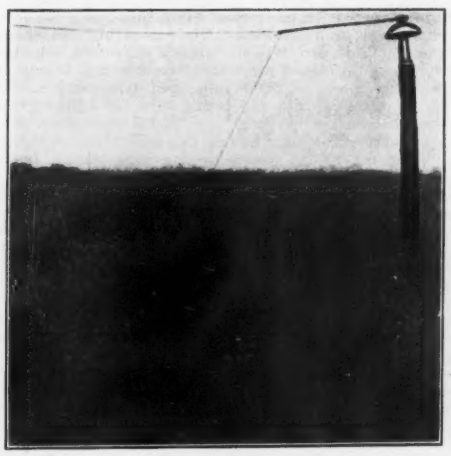

Fig. 5—POLE AND INSULATOR, LINCLUDEN

tables the results were a little variable. Mr. Newman had obtained in his Bristol experiments gains of 17 per cent. in cucumbers, 36 per cent. in strawberries—five year old plants—and even better returns with younger plants. Celery, on the other hand, only gave a 2 per cent. increase, and tomatoes no gain from the application of electricity, while broad beans were reduced in yield 15 per cent., but were ready for picking earlier. At Evesham the improved yield of mangolds was estimated at 25 per cent. The Bristol results with strawberries were repeated, and raspberries showed a marked improvement in growth in the new wood. Here, too, there was a gain in the yield of tomatoes. Mr. Newman, who is now on special leave from the Army, which he joined at the outbreak of war, has begun experiments with electrified crops on his own farm. The electrified area for the present season is only two acres, owing to the fact that Mr. Newman only commenced the work about three months ago. One acre of wheat and one of mangolds is being grown against similar crops in special adjoining control areas. The generating plant is a 4 horse-power Lister internal combustion engine using petrol as fuel, but it is also employed to provide power for the ordinary farm work. The engine drives a 1-kilowatt dynamo, and the ordinary Lodge apparatus is employed. The plant at Pershore was set in operation this year on May 26th, and as all the accumulated experience suggested that intermittent application yielded the best results, the discharge has been applied on that system. At the time of a visit paid by a representative of THE ENGINEER in the middle of June, there was, even at that early period, a slight but perceptible difference in the crops grown under the influence of the discharge. Further data as to the actual results will be available at a later date.

An interesting fact, which has been noted by earlier observers, and to which reference may here be made, as it has been confirmed by Mr. Newman's work, is that many atmospheric impurities will move under the influence of the potential gradient under the wires, and in industrial districts will lead to the precipitation of many harmful substances on the plants. It has been noted that in greenhouses near large towns the discharge results in a serious deposition of dust on the glass, enough sensibly to interfere with the amount of light, and to make the prospect of successful application in greenhouses quite doubtful.

Miss Dudgeon's experiments, carried out partly in conjunction with the Board of Agriculture, are of considerable interest. Beginning in the year 1910 with an experimental area of about a quarter of an acre she has continued the work down to the present time. In 1911, in conjunction with a local farmer, Miss Dudgeon was able to obtain comparative results from an area of seven acres, half of which was electrified and the other half used as a control. The crop was potatoes, and the extra weight per acre from the electrified plot was 1 ton 9 cwt. 2 quarters 20 lb. In 1915 and last year oats were chosen as the experimental crop at Lincluden, a large field which had given uniform crops in the past being selected. Apparatus of the Lodge-Newman type—the present installation is illustrated in Fig. 4—has been in use throughout at Lincluden. Last year, with the object of confining the discharge to the special area to be electrified, the height of the wires was reduced. They were placed at a height of 7ft. and 4½ yards apart, and owing to these changes the intensity of the charge received by the crop was much increased, notwithstanding the employment of a lower voltage. Professor V. H. Blackman and I. Jorgensen, in their report on the results, state that the electrified areas, compared with the control areas, gave an increased yield of 20 bushels (840 lb.) of grain—14 bushels of first quality and 6 bushels of second quality—and 2395 lb. of straw. Calculating the percentage increase over the two control areas the following result is reached:—Increase in grain 49 per cent.; increase in straw 88 per cent. After making allowance for the large experimental error inherent in agricultural experiments where the number of plots is small, it is clear that these results taken in conjunction with those of 1915 demonstrate that under the conditions of the experiments oats respond very markedly by an increased yield both in grain and straw to the action of the overhead electric discharge. A new and important aspect of the problem has been disclosed by the discovery through recent experiments that the application of the discharge one year may increase the size of the crop the next year, *i.e.*, there may be a marked after effect. If in addition to an immediate increase of the treated crop the electric discharge may also benefit a succeeding crop, it is obvious that the agricultural value of the application of the discharge becomes very much enhanced. The apparatus which has been used to produce the necessary high-tension current is, however, regarded by these authorities as comparatively inefficient, and not such as would be used for work on a large scale.

Mr. William Lowe, who has been carrying out experiments at Balmakewan, Kincardineshire, after obtaining some fairly satisfactory results in earlier years, only obtained indecisive results in 1916. The opinion of this worker, who had attempted to apply the electric discharge method to ordinary farm practice, is that the electric radiation only acts as a stimulus when the plant is in active growth.

Of the recent experiments abroad, those in Germany may be mentioned. They illustrate the readiness of our great trade rivals to test any new invention or method of working. Almost before the Agricultural Electric Discharge Company reached the stage of having applied the Lodge method of producing high-tension current tension to farm work, Professor Breslauer, who had been engaged in electrical engineering in England, realised the significance of the movement, visited the Evesham installation, became the German agent of the Company, and in a very short time obtained orders for more sets that there had been inquiries about the subject in England. Six sets were delivered, and Mr. Newman, who visited Germany in connection with this work, is able to give some information as to the work done. One set was installed at Herde in East Prussia, one at Halle in Central Germany, another at Prague, and the others elsewhere. Two of the installations obtained quite good results, an increase of about 25 per cent. in the crop yields being reported, sugar beet being one of the crops. In this case there was a proportionate increase in the sugar content. A set has also been sent out to Java for tests on sugar, but no information is available as to results, and another set, we may add, has been sent to the United States Bureau of Agriculture at Washington.

The work, which is to be undertaken on behalf of the Board of Agriculture, is designed thoroughly to test the effect of electricity on plant growth, and a

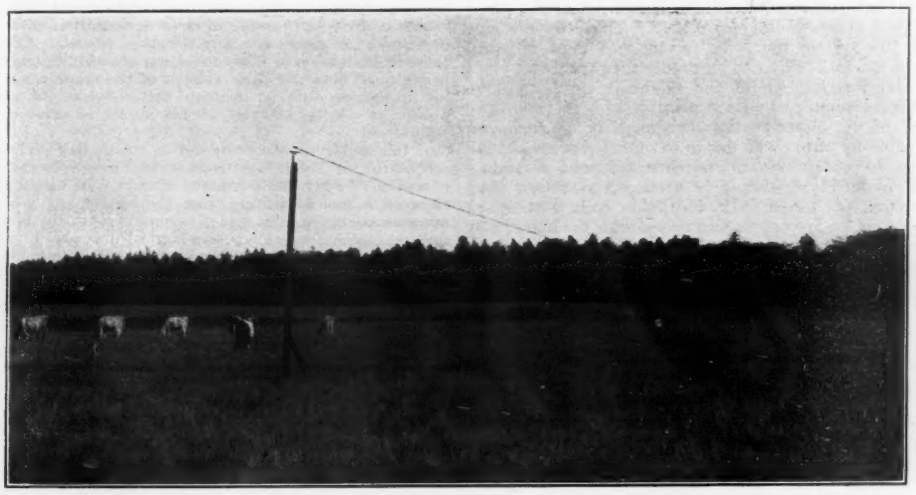

Fig. 6—OVERHEAD NETWORK AT BALMAKEWAN

grant for the purposes of this research has been made by the Development Commissioners. It is generally agreed that before the use of the overhead electric discharge can be recommended to farmers more knowledge on many points must be available. One point may be emphasised; it is deemed desirable to test various methods of producing the necessary high-tension current, and in this connection it is understood that the services of Dr. W. Duddell had been secured before his breakdown in health.

The work which is being put in hand at Hereford on behalf of the Board of Agriculture by Professor Blackman and Mr. Jorgensen, in conjunction with Mr. W. T. Kerr, the city electrical engineer, and with

the co-operation, it is understood, of Mr. Newman, will include an experimental area of 60 acres of various crops, and the test of a different type of discharge apparatus and design of equipment. The first overhead equipment on the Huntington Court Farm, which has been selected for the experiments, is to be 8ft. from the ground. For main side poles 8in. butts, 14ft. high, are being employed, one set placed in concrete blocks in the hedges so that the poles can be removed during harvesting operations. In the fields movable light poles set 130 yards apart are to be used, and these poles will carry a pin-type insulator supporting the main wires, the side poles carrying suspension link-type insulators horizontally attached to a turnbuckle. The fine distributing wires of 30 S.W.G. will be spaced about 4 yards apart. The positive discharge from the machine is to be connected up to the main suspension wires and the negative well earthed. Experiments have shown that the weight of the end wires with use of the turnbuckle pulls up the light wires and keeps them taut. The comparatively low height of the discharge network will enable a low pressure to be employed, probably 60,000 volts. The first discharge apparatus to be used is of the Snark type, supplied by Messrs. Newton and Wright, which is to be tested at this and other experimental stations. Mr. Kerr has himself been working for several years with a garden equipment consisting of a 10in. coil and mercury break apparatus, but he is anxious to develop a more suitable apparatus for general use in commercial agriculture. Owing to the late start it is not likely that much can be done at Hereford this season except with swedes.

At Chester Mr. S. E. Britton, the electrical engineer, who is chairman of the Committee on the Development of Electricity in Agricultural Areas, formed by the Incorporated Municipal Electrical Association, of which Mr. Kerr is also a member, is carrying out experiments with electro-culture on three separate areas of 1½ acres, 10 acres, and 14 acres respectively. The 1½ acres area, which was equipped at the beginning of June, is planted with garden produce; the 14 acres area, which was equipped at the end of June, with potatoes, mangolds and swedes; and the 10 acres area, which was completed in July, has been planted with oats. The apparatus used in connection with the 1½ acres area is a Sanax motor interrupter, Leslie Miller 10in. coil, and Lodge rectifiers; the 10 acres are operated with apparatus supplied by the Agricultural Electric Discharge Company, which consists of a heavy discharge coil, motor-driven gas current interrupter, and five Lodge valves; the 14-acre plot is equipped with a 12in. heavy discharge coil, motor-driven mercury-driven interrupter supplied by Messrs. Harry Cox and Co., Limited, and four Lodge rectifiers. The current is carried from the apparatus to the field by bare galvanised wire, strained from wooden poles, and insulated with high-tension strain insulators, to which are attached discharge wires of No. 30 S.W.G. steel wire. The source of supply in each instance is direct current.

The main object of testing different types of apparatus is, that at the present time the question of cost may prevent many farmers from making practical tests. The first outlay in applying the Lodge-Newman system to 24 acres has been estimated at £300, with an annual upkeep of £63, while the plant for 300 acres would cost £1500. These figures rule out the system for grass farms, and limit it, until the financial outlay can be reduced, to fruit and other special farming where the financial yield per acre is high enough to make it possible to bear the initial cost of an electrification scheme. It is, however, possible for those who desire to make tests on a small scale to obtain small experimental sets, including switchboard, regulating resistance, switches, &c., mercury gas interrupter, induction coils with spark gap, four Lodge valves and accessories for about £70, and a good many sets of this type have already been supplied. This is not, however, practical farming, and if the work now in progress yields definite information on some of the disputed points, the application of electro-culture to large scale farming that the Board of Agriculture desires to bring about may result. What is being done both from the engineering and the agricultural standpoint will be followed with the keenest interest by all who recognise the new importance which must be attached to the agricultural future of Great Britain. No lesson of the war is more insistent than that more of our food requirements must come from home sources of supply, and if electro-culture can be applied with the certainty of increased yields as compared with ordinary farming, and at costs which do not prohibit their extensive application, it would prove a national gain of no small value.

A list of the various publications from which information has been quoted is appended. We should also like to express our indebtedness to the Agricultural Electric Discharge Company, to Mr. J. E. Newman, to Miss Dudgeon, to Prof. Blackman, and to Mr. Kerr and Mr. Britton, for supplying information and photographs.

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THE EDUCATION OF APPRENTICES.

At a Council meeting of the North-East Coast Institution of Engineers and Shipbuilders, in November, 1916, a memorandum on the education of apprentices was submitted by the secretary, and the principles set out therein were adopted. A special committee was appointed to draft and submit to the Council a detailed scheme for the carrying out of these principles. This committee met on December 6th, 1916, and subsequent dates, and considered the matter from all points of view, and has now submitted a report, from which we take the following portions:—

Pre-apprenticeship Education.

After considerable discussion the committee agreed that prospective shipbuilding and engineering apprentices should be drafted from the ordinary classes of the public elementary school into suitable schools providing education other than elementary, in which the prospective apprentice would receive a three years' course of directed preparatory education before beginning their apprenticeship, and that, wherever possible, the place of this further education would be a junior day technical school. The age of admission or transfer from the elementary school to junior day technical schools should be from 12 to 13 years of age, so that the three years' course of instruction should be completed before the boy begins his apprenticeship at 15 to 16 years of age. A reasonable proportion of the teachers in the junior day technical schools will have had practical trade experience in engineering and shipbuilding; though this does not mean that any attempt to teach the trades will be made. It is a recognition of the desirability of the foundations being laid by persons having some knowledge of the superstructure.

Boys from secondary schools who become ordinary apprentices at about 16 years of age, will take their place in the system to be described in the further part of this report dealing with "Education of Youths during their Apprenticeship." It is recognised that a good secondary school must provide a general education with such instruction in specific subjects that a boy on leaving school at about 16 years of age will enter naturally into the course at the point suited to his attainments. It is essential that, during this period, character should be formed, habits of industry inculcated, culture developed, and the sense of citizenship be implanted, so that the boy, on starting his apprenticeship, shall aim strenuously at becoming a good workman, at fitting himself for more and more responsible work, and at developing a sound citizenship. In connection with junior day technical schools there should be representatives of employers and employees associated with the management in a consultative capacity, so that a true proportion shall be maintained between the academic and vocational side of the education.

If junior technical schools are to be established and maintained by the Education Authorities, it is essential for their success that employers should give preferential appointment to those youths on passing out of the schools, and the periods of efflux of those pupils must be arranged to suit the requirements of the district. It is urgently necessary that nepotism, in this connection undoubtedly existent, should be eradicated. The selection of apprentices should be made by a competent member of the works administrative staff acting in close consultation with the headmaster of the junior day technical schools. Official Labour Exchanges in this connection are of infinitely less importance than the clear concept of the employer as to his necessities, and the intimate knowledge of the headmaster as to the abilities of his pupils to meet those necessities.

A full and generous provision of junior day technical schools for the North-East Coast would provide for the day education of a very large number of boys, who would have received a sound training from the age of 12½ years—approximately—to the age of apprenticeship, in mathematics, mechanics, science, mechanical drawing, English, and in the working of wood and metal. The annual draft of these boys into the works should, in a very few years, produce a marked rise in the general intelligence and potentialities of the workmen, and this conclusion becomes more apparent when it is borne in mind that it is proposed to build on this suitable preparatory education—without break or delay—during the years of apprenticeship as described in the following sections.

Education of Selected Youths During Apprenticeship.

The large number of well-trained boys emerging from the junior day technical schools will be joined by a comparatively small number of boys entering upon their apprenticeship at about 16 years of age, direct from the secondary schools, and of this total there will be a small percentage with exceptional ability, solidity of character, and general promise. The committee proposes that the education of these exceptional youths should be on different lines from that of the general body of apprentices, because it is from the comparatively few youths of exceptional ability and sterling character that the future foremen and higher officers of industry will emerge in greater proportion.

It is proposed that these youths of exceptional promise should be engaged half of each week as apprentices in the works and half time as students in the local technical college. This education would continue for two years, that is, from about 16 to 18 years of age, when a second selection would be made from these exceptional boys at the age of 18 years. Those selected the second time must have shown all that is implied in "staying power," character and work, and should pass direct to the university for the full engineering or naval architecture degree courses. It is not anticipated that the number so selected will be more than a very small percentage of the total number of boys entering the industries from the junior technical schools, and it should be incumbent upon the Education Authorities or the State to provide scholarships and maintenance grants, so that the poorest boy may have a straight road from the elementary school to the completion of his university course, freed from the anxiety of providing ways and means.

Education During Apprenticeship of those Youths not Selected for Special Treatment.

The selected boys, having been withdrawn from those passing from the junior day technical schools to the works, the remainder, a large percentage of the total number, must continue their education without break during apprenticeship, and under such conditions as will enable this to be done without undue drain upon their energies and vitality. The committee approves the Council's recommendation that these youths should be liberated for at least two, and, if possible, three half-days a week for the purpose of their technical education. There should be no reduction in wages on account of such attendance. The curriculum should be a continuance of that of the junior day technical school with modifications and should be on broad lines, such as is now being developed in the best types of evening continuation classes.

For the full development of the mechanical ability of the apprentice, it is imperative that employers should provide definite practical instruction by expert craftsmen in the shops, and that this instruction should be continued throughout the whole of the apprenticeship. The committee believes that the extra expense involved, both in this arrangement and in the absence of apprentices during class hours, will be returned to the employers in a far higher degree, on the one hand, by the greater skill of the workman, and, on the other hand, in the broader mental outlook and initiative of the individual.

In presenting this report to the Council the committee urge, most strongly, that now is the time to press upon the Local Education Authorities the consideration of this scheme, with a view to its being put into operation at the earliest possible moment. The best boys, now in the upper standards of the elementary schools, who have determined to enter in due course either the engineering or shipbuilding industry, need to begin their three years' course of instruction in the junior day technical schools at once, as it will be nearly three years from the date of starting before they will enter the works as apprentices. In conclusion, the committee agrees that the Institution should act as representatives of the Employers' Association in connection with engineering, shipbuilding, and ship repairing on the North-East Coast in a consultative capacity with the Local Education Authorities for the development of apprentice training in technical education.

This report has been received and adopted by the Council of the North-East Coast Institution of Engineers and Shipbuilders, and has been submitted to and considered by the following Employers' Associations:—The North-East Coast Engineering Trades Employers' Association, the North-East Coast Ship Repairers' Association, the Tees and Hartlepool Shipbuilders' Association, the Tyne Shipbuilders' Association, the Wear Shipbuilders' Association. The last-named association expresses full sympathy with the objects aimed at, and the others generally approve of the scheme. All the associations appoint the Institution to act as their representative in a consultative capacity with the Local Education Authorities for the development of apprentices' training in technical education.

NEW SUB-STATIONS FOR THE HALIFAX DISTRICT.

In order to afford a supply of continuous current to the outlying areas of Hebden Bridge and Hipperholme, the Halifax Corporation has recently laid down two converting stations in those districts. The converting unit chosen is the 250-kilowatt "Witton" rotary converter, together with an oil insulated air-cooled transformer, taking in three-phase power at 6600 volts, and generating at 550 volts for traction, and 220–0–220 volts for lighting, the rotary converters serving the double purpose. The Hipperholme sub-station having two converting units, has two incoming feeder panels on the high-tension board and two machine panels. That at the Hebden Bridge has but one machine panel. For the purpose of keeping constant the voltage across the three-wire network, the neutral wire is taken from the star-point of the transformers. The rotary converters run at a speed of 1000 revolutions per minute, and are designed for reactance control. They are of the self-synchronising pattern, and run up to speed by a starting motor and switched in through choking coils.

The low-tension boards include both traction and lighting panels, and a simple arrangement of interlocks between the liquid starter for the motor. Change-over switches are also included on the board for applying the machines either to lighting or traction, and these switches make provision for the opening of the neutral connection when the machines are required for the latter purpose. The whole of the plant was supplied by the General Electric Company, Limited.

According to Prof. Thomas H. Norton, the cost of nitric acid made by the Birkeland and Eyde process of fixation of atmospheric nitrogen was but little more than half that of the acid from Chili saltpetre at 1914 prices, and by the Ostwald process, from ammonia obtained from cyanamide in the first place, even less than half. The production of ammonia in Germany by the Haber synthetic process, according to the *Frankfurter Zeitung*, rose from 30,000 tons in 1913 to 60,000 tons in 1914, 150,000 tons in 1915, and 300,000 tons (estimated) in 1916. An output of 500,000 tons of ammonia is anticipated in 1917, containing 100,000 tons of nitrogen; at the same time 700,000 tons of sulphate of ammonia (140,000 tons of nitrogen), and 400,000 tons of calcium nitrate (80,000 tons of nitrogen) are expected to be produced, the total including 320,000 tons of nitrogen.

RAILWAY MATTERS.

THE Prince of Wales has accepted the presidency of the Railway Benevolent Institution. As it was founded in 1858 next year will be the diamond jubilee of the Institution.

ON and from August 1st all wagon ropes belonging to British railways will be used in common. In our issue of March 30th we stated that all the wagon sheets had been pooled, and this is a sequel thereto.

JUDGING from Mr. Macpherson's reply to a question asked in the House on July 13th, the platelayers and other permanent-way men from Ireland who were working in France have now returned to their own country.

ON page 11 of our issue of July 6th it was stated that M. Sartiaux had been obliged, through ill-health, to resign the position of general manager of the Chemin de fer du Nord. To the position thus vacant M. Paul Javary has been appointed. M. Javary was chief assistant to M. Sartiaux.

FURTHER questions were asked in the House on July 11th as to the Belgian locomotives in France which were not being used in traffic. To this Mr. Macpherson replied that to give the information requested would involve entering into details of negotiations with foreign Governments which could not be made public.

WHEN the East-West Transcontinental Railway of Australia is opened, which it is now hoped will be by the end of August, it is proposed to run two trains per week in each direction. The standard composition of each train will be: two second-class sleeping carriages, two first-class sleeping carriages, one dining car, one first-class day car, one mail van, and one brake-van.

THE Committee on Car Service of the Advisory Commission of the Council of National Defence in the United States has recommended the Government purchase of 100,000 gondola cars and 50,000 box cars. The Executive Committee, whilst welcoming the suggestion, has pointed out that additional power and terminals would be more effective, and that the railways have 100,000 cars still undelivered on order from the manufacturers.

THE Public Utilities Commissioners of New Jersey have reviewed the action of the Erie Railroad in discontinuing the operation of seventy-seven passenger trains and have found no fault with the arrangement. The Commissioners say that if they can be advised of such moves as this, with an explanation of the reason, set forth in some detail, they can explain matters to the public without requiring the officers to appear at the hearings.

As both the South-Eastern and Chatham and London, Brighton and South Coast Companies are among the lessees of the East London Railway, it appears strange, as indicated by the answer to a question addressed to the Board of Trade on July 16th, why the former company does not issue season tickets to the East London stations whilst the Brighton company does. Mr. Roberts said he would communicate with the Railway Executive Committee.

BY a presidential decree, issued a short time ago, the Argentine Government abolished the technical office until recently maintained in London for the inspection of supplies purchased in Europe and the United States for the Argentine State and other railways and public works. The office was created in 1909, and the reason given for its suppression at this time is that with the marked falling off in railway purchases and the diminished activity in the prosecution of public works, there is no necessity for maintaining a separate organisation for technical inspection.

ANSWERING a question on July 20th as to the Taff Vale, Rhymney and Cardiff Railways' working agreement, and as to whether steps had been taken to safeguard the interests of the employees, Mr. G. H. Roberts said that as to the second part of the question, the separate interests of the three companies were, for the time being, subject to the fact that the companies were under the control of the Government, but complete and permanent fusion would require the sanction of Parliament and would be subject to any conditions affecting labour or otherwise which Parliament should think fit to impose.

A NOVEL method of repairing worn armature shafts on the commutator end of its motors is being employed by the Elmira Water, Light and Railroad Company. Steel tubing, which has an outside diameter equal to that of an unworn armature shaft plus a very thin skin cut, is employed, and the worn shaft is turned down so that the tubing can be put over it with a shrink fit. To ensure a tight fit between the sleeve and the shaft a circular groove is cut in the end of the shaft along the joint between the steel sleeve and the shaft. This groove is then welded full of metal and the shrink fit and the weld are said to give the required strength.

THE value of railway material exported during the six months ended June 30th was as follows, the figures for the corresponding period of 1916 being given in brackets:—Locomotives, £742,159 (£586,598); steel rails, £314,433 (£276,200); carriages, £103,295 (£231,217); wagons and trucks £235,763 (£335,693); wheels and axles, £79,231 (£165,488); tires and axles, £298,668 (£254,423); chairs and metal sleepers, £52,146 (£56,569); miscellaneous permanent way material, £235,346 (£248,739). The total value of permanent way material exported was £604,612 (£623,534); of rails there were 3732 tons (31,689 tons); and of chairs and metal sleepers, 5410 tons (5410 tons).

AN unusual accident occurred last month to a mixed train on the Kohat Thal Railway between Doaba and Kahi. The train, which consisted of seven third-class carriages, one composite, and two brake vans, on going round a bend was struck by a very violent storm which upset the whole of it, the engine alone remaining on the metals. As soon as it was possible, the engine was cut off and it ran into Kahi for assistance. Two third-class passengers were killed and five injured. No great damage was done to stock or permanent way. The storm was reported to be extremely violent. The driver was trying his best to get into a cutting for protection, but the train was blown over before he could reach it.

NOTES AND MEMORANDA.

THE original inventor of the sparking plug was Lenoir. The type of plug which he designed for use in connection with his ignition scheme in 1860 had all the features of the modern plug.

THE melting point of raw zirconia is in the neighbourhood of 2000 deg. Cent., that of the purified material being considerably higher. It can be both melted and volatilised in the electric furnace. It is a "neutral" substance of the same type as alumina and is said to have a high resistance to the fluxing action of both acid and basic slags. Its heat conductivity is remarkably low, and its co-efficient of expansion on heating is nearly as low as that of quartz glass, both of which are very valuable properties. It resists the action of fused cyanides and alkalies.

EXPERIMENTS carried out at the Engineering Experiment Station of the University of Illinois in 1915 showed the advantages of certain iron-silicon alloys, for electromagnetic uses. Other researches on iron-aluminium alloys melted in vacuo have shown that aluminium, like silicon, greatly improves the magnetic properties of the metal, and also that aluminium imparts to the metal a greater toughness than silicon. These results are summarised in Bulletin No. 95, copies of which can be obtained from Mr. C. R. Richards, Director of the Illinois Engineering Experiment Station, Urbana, Illinois.

IN addition to motor tractors, steam ploughs and other self-propelled machinery of the Agricultural Machinery Department of the Ministry of Munitions, it may be mentioned that Mr. S. F. Edge, the Controller of that Department, has issued a notice asking for tenders for the following implements, among others: 8000 horse-drawn ploughs; 2000 cultivators; 2000 seed drills; 2750 rollers; 5500 harrows of ridged and jointed type; 400 land presses; 7000 self-binders; 1400 disc harrows, both tractor and horse-drawn; 400 horse-drawn farm tip-carts; 100 horse-drawn flat top lorries; threshing machines—3ft. 6in. and 4ft. 6in.; cultivators for tractors; and some thousands of two-furrow ploughs for tractors.

U BOATS are said, by the *Rivista Marittima*, to have been constructed without periscopes, and an alternative arrangement, having none of the disadvantages of visibility, has been adopted instead. The new system, which would appear to be in the experimental stage, consists of two lenses, one on either side of the submarine, which are used in conjunction with other lenses and reflectors. The drawback to the device is stated to be that the craft must be navigated nearer the surface than would be the case were a periscope fitted, but this drawback is claimed to be a lesser disadvantage than showing a periscope of the usual type. Another feature of the instrument is that a beam of light can be projected through the lens.

A COMPANY called the Shawinigan Water and Power Company is preparing designs for a 5000ft. clear conductor span for the transmission of electric energy over the St. Lawrence River at Three Rivers, Que., which will supplement the submarine cable transmission line already installed. Each of the steel towers on which the line will rest at the extreme ends of this long span will have a concrete base, set some little distance from the bank of the river. The towers will be 350ft. high, so as to provide a clearance of 160ft. in the centre of the span. The three conductors will be placed approximately 50ft. apart. The transmission line will not be anchored to but merely supported by the towers and anchored to concrete blocks situated some distance to the rear of the towers.

ACCORDING to a recent report, a company is being organised known as "Russian Jute" company, and its object is to erect a factory of considerable size at Iekaternioda for treating a textile plant known as "kenafé." which is said to possess the properties of the jute plant. This plant, says the *Scientific American*, is very abundant in Russia, and has been utilised for a long time past by the peasants for making twine for binding sheaves, but this is the first attempt to make use of the plant on an industrial scale. It is claimed that the fibre will answer very well for making bags, packing cloth, cord or twine, and all the well-known products which are made up from jute. The enterprise is being mainly promoted by leading jute and flax interests at Petrograd and Moscow.

IN certain districts where feed water for boilers contains sodium hydroxide, many boiler troubles have appeared which have given no little concern to boiler users and makers. The engineering experiment station of the University of Illinois has just completed an investigation of this source of boiler distress, and the results are published in Bulletin 94, by S. W. Parr. It was noted that boilers using feed water containing sodium hydroxide often developed fine cracks radiating from rivet holes or extending from hole to hole. The experiments showed that the effect upon the metal is to cause brittleness, which makes it less capable of withstanding steam pressure and temperature changes. Among the remedies suggested, according to the *Iron Age*, is the addition of a salt having properties which cause it to react with the alkali and yield a harmless product.

RECENT improvements in searchlights have taken the form of various methods of cooling the electrode with a view to obtaining greater local concentration of the light, either by a spray of alcohol, or, as in the Sperry searchlight, by a blast of air. Another line of development being investigated in Germany has been the use of arcs under high atmospheric pressure. Lummer was reported to have obtained promising results shortly after the outbreak of war, and it was thought possible that a considerable improvement in the efficiency of arc lamps and projectors might be secured in this way. According to some experiments described in the *Elektrotechnische Zeitschrift*," this anticipation is not being realised. Pressures varying from a vacuum up to five atmospheres compression were utilised, both with inclined and vertical carbons. In the former case a marked gain in efficiency was secured, but the arc was found to become very unstable for pressures exceeding one atmosphere, says the *Electrician*. On the other hand, with vertical carbons more stable conditions are realised, but the gain in efficiency seems to be very moderate.

MISCELLANEA.

THE first electrically-driven reversing mill to be installed in Monmouthshire or South Wales has recently been set to work.

A NEW YORK organisation called the Society for Electrical Development has issued a booklet giving a list of more than 3000 applications of electricity, and it has been sent free to its members.

THE transfer of the offices of the Department of Scientific and Industrial Research (including the Fuel Research Board) to 15, Great George-street, which is nearly opposite to the department's present offices, took place on the 23rd and 24th inst. There is no change in the telegraphic address, which remains:—Resciendus, Parl., London, and the official telephone number is, as before, Victoria 7940.

THE supplement to the *Board of Trade Journal* of July 26th contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from the Straits Settlements, Hong-Kong, Nigeria, Jamaica, Barbados, Trinidad and Tobago, and British Guiana. Copies of the supplement may be obtained at a cost of 3d. (4d., post free), either through any bookseller, or directly from H.M. Stationery Office, Imperial House, Kingsway, London, W.C. 2.

AT the request of the Committee on Commercial and Industrial Policy (Lord Balfour of Burleigh, Chairman), the Council of the Institution of Mechanical Engineers recently appointed the following gentlemen to give evidence relating to proposals for the compulsory adoption of the metric system of weights and measures in the United Kingdom:—Dr. William H. Maw (Past-President); Mr. William H. Allen (Vice-President); Sir Robert A. Hadfield, F.R.S. (Vice-President); and Sir Vincent L. Raven (Member of Council).

ACCORDING to a Dutch paper, a meeting of leading persons in the industrial and banking world was called recently at the Hague by Dr. Lely, Minister of Water Engineering, to discuss the erection, with the assistance of the Treasury, of blast-furnaces and rolling-works in Holland. The cost of the scheme is estimated at rather over £2,000,000. The result of the discussion is not yet known, but it is thought that the proposals have a fair chance of being adopted. The utter dependence of Holland upon foreign countries during the war for the supply of the means necessary for her defence has helped to lift the plan from the theoretical into the practical sphere, and the necessity of emancipating the country from the control of foreign industrial syndicates is being felt more and more.

THE Board of Direction of the Institute of Radio Engineers has decided to award annually a "Medal of Honour" to those persons who have distinguished themselves by unusual advances in the fields of radio-telegraphy and telephony. The medal is the work of the well-known sculptor, Edward Sanford, jun., of New York, and the award will be made yearly at the April meeting of the institute to the person who during the two preceding calendar years shall have made public the greatest advance in the art of radio communication. The first medal, says the *Wireless World*, will be presented to Mr. Edwin H. Armstrong, of Columbia University. The medal is being awarded to Mr. Armstrong in recognition of the work he has done in connection with receiving apparatus which employs the Armstrong circuits.

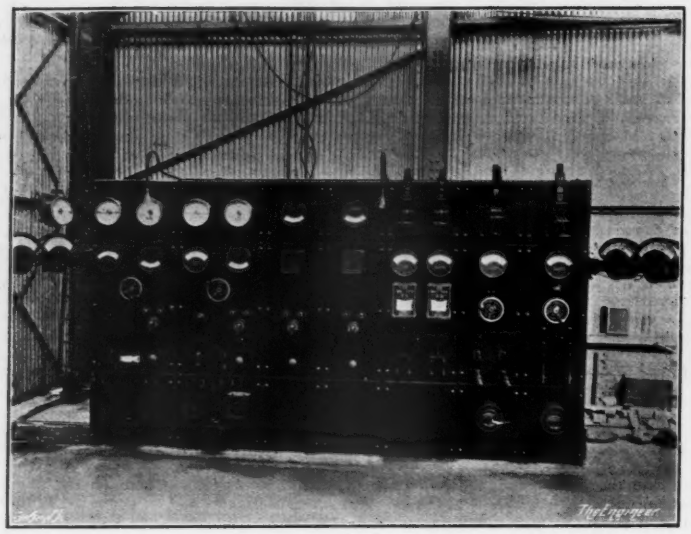
SOME weeks ago the Board of the Manchester Chamber of Commerce appointed a Special Committee to examine the possibilities of a scheme for bringing into closer co relationship those who require motor lorry accommodation and those who had it to offer. It had been brought to the notice of the Board that very frequently motor lorries after undertaking a journey in one direction with a full load returned to their place of origin empty, although there was often enough traffic offering which could have been brought back. This naturally implied wasted labour and fruitless expenditure of petrol. After careful consideration the Motor Transport Committee has received the authority of the Board to open an office with a manager and the necessary staff. A radius of from 30-40 miles is in contemplation, and communications are being entered into with other Chambers of Commerce in Lancashire with a view to a concerted effort.

SINCE the outbreak of the war, applications have been received at the Department of Commercial Intelligence from a large number of firms in all parts of the United Kingdom, and abroad, which wish to get into communition with British manufacturers or producers of various classes of goods which have previously been obtained from Germany and Austria-Hungary. Applications have been recently received for the names of manufacturers or producers of the following articles; British manufacturers or producers of these articles now in a position to supply are invited to make application for the names of the enquirers:—Carbon electrodes; diamond dies for wire drawing; drawing pins; boilers designed for using peat as fuel; gas generators designed for peat; machinery for excavating and generally handling peat; maize oil; paper, nature casings; school chalks; tin, brass and copper linings and angle plates for ammunition boxes.

THE constant motion of a wire rope involves heavy strains and internal friction, and requires that the wear should be equally distributed. Intelligent lubrication will greatly prolong the working life of a wire rope, says the *Ironmonger*. The initial lubrication used to lay up the hemp core around which the strands of the rope are wound is an important factor, as it should not only retard the effects of friction but also act as a preservative by minimising internal corrosion. When a rope is properly lubricated from the inside less external lubrication is necessary, and the same lubricant should preferably be used in both cases to obtain uniform results. The necessity for careful lubrication will be realised when it is stated that the wearing or bearing surface of 100ft. of 1in. diameter wire rope is about 334 square feet, whereas the bearing surface in a 35,000 horse-power reversing engine, one of the largest in the world, is 319 square feet.

GREAT LAKE HYDRO-ELECTRIC POWER PLANT, TASMANIA

(*For description see page* 69)



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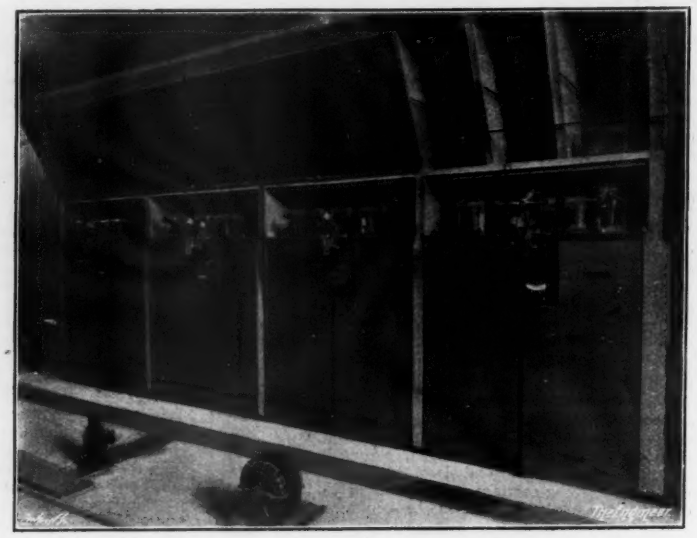

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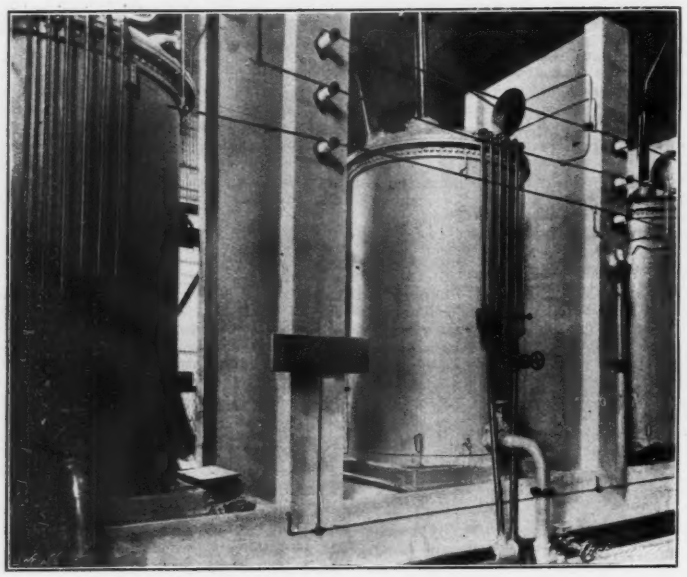

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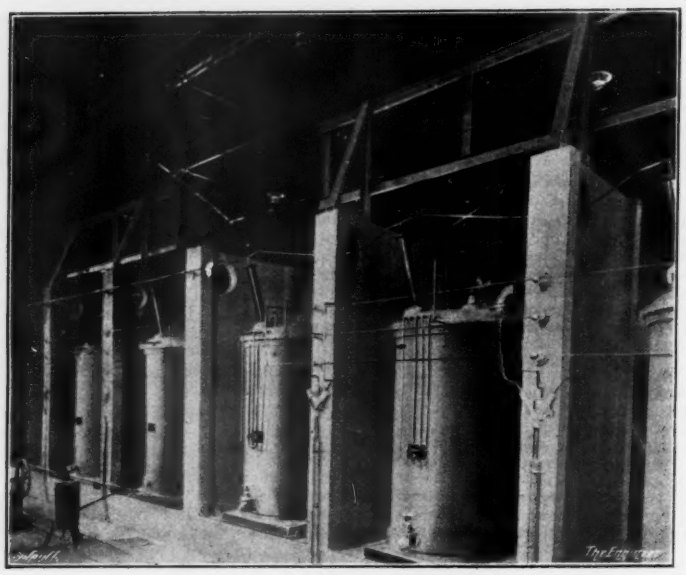

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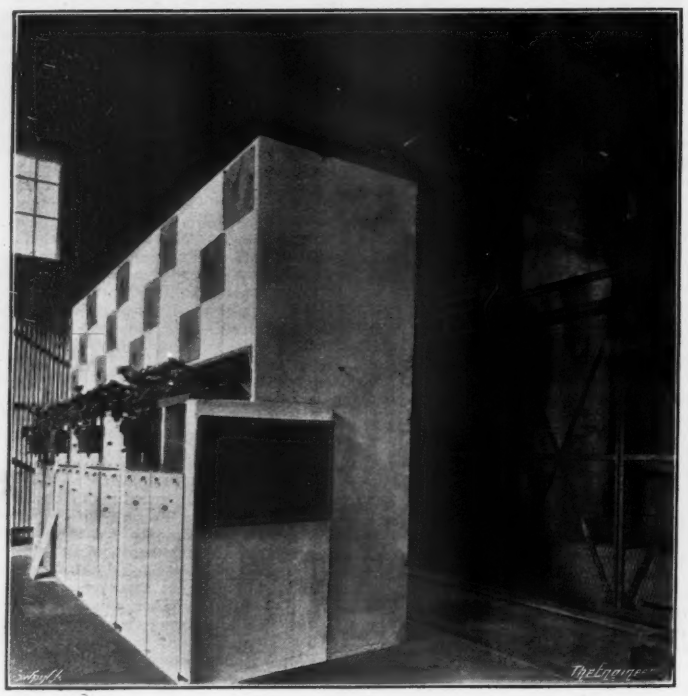

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*** *With this week's number are issued as Supplements a Two-page Engraving of the Tasmanian Great Lake Hydro-electric Power Scheme; also the Index to Vol. CXXIII. Every copy as issued by the Publisher includes copies of these Supplements, and Subscribers are requested to notify the fact should they not receive them.*

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TWO-PAGE SUPPLEMENT: THE GREAT LAKE HYDRO-ELECTRIC POWER SCHEME, TASMANIA. INDEX TO VOL. CXXIII.

TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.

THE ENGINEER.

JULY 27, 1917.

Industrial Unrest.

WHEN eight commissions on industrial unrest were appointed on June 12th, it was hoped that they would be able to present their reports in four weeks. They did not succeed in doing so, but in view of the scope of their inquiries no one will complain because they have taken a week or so more than the allotted time. Their reports have been for some days in the hands of the War Cabinet, and will probably be issued to the public next week. In the meantime the wise course has been taken of publishing a summary of the findings, written by Mr. George Barnes. With it most of our readers are already conversant, for it has been widely reprinted in the daily Press. No critical examination is possible of a document which is professedly no more than a *précis* of much longer and more detailed papers. We cannot, however, fail to notice that the investigations of the Commissioners have led to the discovery that there are a great many causes of complaint, and we do not hesitate to say that had the Commissioners extended their inquiry over another month they would have found double the number. Indeed, the conclusion is forced upon us that the working public seized the opportunity of the inquiry to ventilate the grievances of each district, and that some are of no more than local interest. We do not for one moment suggest that local grievances should be neglected, but at the same time we cannot blind ourselves to the fact that no net is more efficient than one spread for grumblers, and that the Government might continue this sort of fishing indefinitely and never get an empty haul. It must, in such circumstances, be the duty of the War Cabinet to attempt to evaluate the various complaints, and to direct its energies to the removal of those that are most widespread, or that have most real substance, whilst leaving the lesser fry to be handled by local management.

In many quarters there has risen an uncomfortable feeling that a revolutionary spirit is abroad in the land, and that certain classes of society are aiming at nothing less than the complete overthrow of all authority. We observe with deep satisfaction that the Commissioners have found no evidence of such a spirit. "A comparison of the reports," writes Mr. Barnes, "shows that there is a strong feeling of patriotism on the part of employers and employed throughout the country, and they are determined to help the State in its present crisis. Feelings of a revolutionary character are not entertained by the bulk of the men. On the contrary, the majority of the workmen are sensible of the national difficulties, especially in the period of trial and stress through which we are now passing." This is extremely satisfactory, for if there is a general desire to do the best that can be done in the circumstances, then the difficulties of clearing away the causes of complaint will be made easier, and in case they cannot be entirely removed they will be regarded with a tolerance which would be lacking were the desire to make trouble more prevalent than it actually is. As a matter of fact, the universal, as distinguished from local causes of unrest, appear to be only three in number. The first is "Food Prices and Distribution of Supplies," and is clearly as much inspired by the belief that a lot of people are "profiteering" as by the actual price of food. It would, we fancy, be safe to say that the workpeople of Great Britain would and could face the present prices of food without grumbling were they satisfied that they were not being exploited. How much truth there may be in the current stories of profiteering we are unable to say. They are probably exaggerated, but in any case it is perfectly clear that they have a large psychological effect, and that they ought to be put down. The other causes are the operations of the Munitions of War Acts and the Military Service Acts. Both these matters have been discussed to the last detail in the Press for many weeks past, and it is unnecessary to say more about them than that they only help to show, what the question of food prices had already shown, that the universal causes of unrest were universally known before even the Commissioners began their labours. In so far, then, as they prove that there does not exist in the country any generally revolutionary spirit—by the way we are not sure that it would have revealed itself before the Commissioners—and that there is no reason of complaint that was hidden and unsuspected, the reports of the commissions must be regarded as reassuring.

Summarising the findings of the eight commissions Mr. Barnes gives us a list of fourteen recommendations ranging from the regulation of food prices to the higher taxation of wealth. Every one of them would form the text for a pamphlet if not a volume. Three of them especially attract our attention, one because it is one of those little details of shop management which should never have been neglected—the payment of bonus to skilled supervisors and others on day rates—and the other two because they raise great issues. The first "recommends" that "Labour should take part in the affairs of the community as partners rather than as servants," and the second that "closer contact should be set up between employer and employed." Of neither it is possible to say much at the end of an article, but of the latter at least we may remark that the problem is already being attacked from, at least, four directions. We have first the Whitley report on Industrial Councils, then the report recently issued by master builders and trades unions, thirdly the National Alliance of Employers and Employed, and lastly a new body with somewhat similar objects brought into being on Friday evening last, and known as the Industrial League, about which we say a few words in another column. It is the prevailing view of the moment that industrial peace is only to be won by complete mutual understanding between employers and employed, and these four forces are all working towards that object from slightly different directions.

The Future of Canadian Railways.

THE report of the Commission which has been inquiring into Canadian railway affairs, summarised elsewhere in this issue, is of more than local interest. Not only is the question as to the future relation between railways and the State one that calls for a settlement in Canada, but it is a subject at present under investigation in India and the United States; in India, in view of the termination, at the end of 1919, of the contract between the Government and the East Indian Railway Company and in the United States, as a result of a promise made by President Wilson. The American inquiry embraces not only the subject of Government control and regulation of public utilities, but also the wisdom and the feasibility of Government ownership, and the comparative worth and efficiency of Government regulation and control as compared with Government ownership and operation.

In Canada the matter arose through the necessity for giving financial aid, a year ago, to two of the railway companies which were in difficulties owing, mainly, to war conditions. This is a state of affairs likely, at the present time, to arise anywhere; but the situation in Canada is the more confused—and therefore the more interesting—because the Canadian Pacific is doing uncommonly well and does not ask for, or need, any assistance. Yet, the Canadian Pacific has in the past received considerable help from the Dominion Government. It has, to quote the report, "made good," but now that the two other principal companies, which have also been helped but in a different way, ask for financial assistance it is to be refused. The Canadian Pacific, we read in the report, was brought into existence and carried through its early difficulties by direct Government support and large financial assistance from public funds. The Grand Trunk was confined to the East, and it wanted to get some of the western traffic; the Canadian Northern was confined to the West and wanted some of the eastern traffic. "And," says the report, "public sentiment, which felt that the growth of the country justified and required more than one transcontinental line, undoubtedly sympathised with the companies' ambitions." The report, a little further on, adds that a very large measure of Government help was given to both companies, and that "an uninformed and unreasonably optimistic public opinion undoubtedly supported this action at the time." The help given to the three companies varied in kind. "There was given to the Canadian Pacific at the outset direct aid with a generous hand, and the aid was continued up to the point when the company could stand alone. The country knew what it was paying." In the

early days of the Canadian Northern no direct aid was given other than a comparatively small grant of land, at the time almost valueless. Since then the company has received subsidies, but it is stated by the Commission that they are very small in proportion to the direct aid given to the Canadian Pacific. The troubles of the Grand Trunk have arisen out of the guarantees it made towards the Grand Trunk Pacific, as to which company the report observes that direct aid was given to a considerable extent; but the financial scheme mainly relied on guarantees, first by the Governments, and secondly by the Grand Trunk Company. Earlier in the report it is remarked that "history shows that the Grand Trunk Railway proper has received much less assistance than either of the other two companies with which it is in competition. The Grand Trunk began as long ago as 1851, before the Dominion of Canada came into existence, and before the modern policy of subsidies and guarantee had been introduced. In the main it has had to rely throughout its history on its own resources, and it has had for many years to compete with heavily subsidised rivals. While it was the pioneer in giving to Canada railway service, its shareholders have never had but very moderate dividends."

We make the above extensive quotations because they go to show that both the Government and the people of Canada are, to a certain degree, responsible for the ill-fortunes that have come over the Canadian Pacific's rivals. Under the circumstances it seems scarcely fair that, as recommended by the majority two members of the Commission, whilst the Canadian Pacific is to be left alone, the other two are to be taken over by what is practically the State. The minority recommendation of Mr. A. H. Smith, who, it must be remembered, is the president of the New York Central Railway and therefore a practical railway man, strikes us as not only a better policy but a fairer one. He recommends that the Canadian Northern should be relieved of its eastern lines and possess territory only in the west, and that the Grand Trunk should be relieved of its western lines and work only in the east. There would be certain gaps, and these should be filled by the Government acting through a board of trustees. As Mr. Smith observes, these portions exist as a result of that public policy which has been discussed and the Government may well afford to take them over and maintain them as necessary parts of the public investment in the country's development. "They are not of sufficient importance to bring about those dangers inherent in Government operation of this kind on a large scale, and holding them will not endanger private enterprise." Both the Canadian Northern and the Grand Trunk will need financial assistance under any circumstances, and this, Mr. Smith recommends, should be given by the Government upon the advice and under the supervision of the Board of Trustees which he has proposed should be appointed to take care of the linking up railways. What, to us, is the special virtue of Mr. Smith's proposal is that it, to a certain extent, allows for the *status quo*; it gives the two Canadian companies, which are in difficulties, the help they need without destroying their present and future usefulness; it retains the private ownership to which all the Commissioners pay such high tribute, and it leaves every opportunity for these two companies, like their successful rival, the Canadian Pacific, to "make good."

LITERATURE.

The Rowan Premium Bonus System of Payment by Results. By William Rowan Thomson, Wh. Sch,. M.I.N.A. Glasgow: McCorquodale and Co., Limited. 1917. Price 5s. net.

No one in the world knows more about the premium system of paying wages than Mr. Rowan Thomson. Years ago, in conjunction with the late James Rowan, who was then the head of David Rowan and Co.—a position which Mr. Thomson now occupies—he worked out a scheme which is widely known as the Rowan system. Its object was, in a word, to overcome the tendency to rate-cutting by making the premium adjust itself automatically, so that, under no circumstances, could the workman quite double his wages. We have so frequently dealt with the system in these columns, and it is so fully described and discussed in our own little book on the premium system, that it would be superfluous to enter into a description of it here. Even before the war the system had made a good deal of progress, in spite of the indifference of employers and the opposition of trades unions; but of recent months the interest in premium systems has enormously increased, because it is now generally accepted by both employers and employed that there is no solution of the double labour problem—how to pay the workmen higher wages and decrease the cost per piece—other than payment by results. The effect of this recrudescence of interest, for which we hope we may take a little credit to ourselves, is that Mr. Rowan Thomson has received frequent enquiries for further particulars of his system, and it is with the object of putting before others all the knowledge of it that he has acquired in many years' experience that this little volume has been written. It is addressed to engineers, and will no doubt be more deeply studied by engineers than by other people; but we should like to take this opportunity of saying that the premium system in skilful hands could be just as well, and just as profitably, used in the manufacture of cakes or shirts as in the making of steam engines and machine tools It is a mistake to suppose that, because it was invented by engineers, it can be used only by them, and in the certain extension of payment by results we expect and hope to see it adopted in other branches of industry.

The premium system raises many economic questions of an interesting and important character. These questions are ably and clearly handled by Mr. Thomson, but if we mistake not, the portions of his book that will be most closely read are those dealing with the experiences of his own firm, and with practical details of the applications of the system. To these matters a good part of the book is devoted. The first is dealt with in a chapter headed "The Effects of the System," which opens with this admirable caution:—"It must not be supposed that the premium bonus system is a panacea for all the ills that workshop management is heir to. Good as it may be, and excellent as it is in very many directions, it is at best a tool, and a tool it will and must always remain. I have never pretended that it is, or will ever be, a substitute for good management—nothing can ever take the place of that—but in the hands of good, honest, and progressive management it will work wonders in many curious and unexpected directions." Mr. Thomson then goes on to show that its use is a liberal education for the employer, and that "those who are open and willing to receive a lesson, and act upon it," can find no better "spur or stimulus than the premium bonus system." He then illustrates by many examples from the wages-book of his firm that "it pays the employer, and it certainly pays the workman handsomely." Moreover, in some cases, it "provides methods of getting at and dealing with all kinds of questions, which, as a rule, are only guessed at under time conditions"—an increase of 29 per cent. in the output resulted from moving a planing machine into a better position. He tells us that "one of the most successful applications of premium bonus is in our smiths' shop," and he deals with the use of the system with squads of men. Examples are given of the increases of wages secured by men working under the system, and in this connection the statement that it has "a stimulating and elevating effect upon the workmen themselves," should be noted.

In the next chapter Mr. Thomson gives his readers a number of useful "Hints on Practical Applications." In these pages he deals with the question of rate-fixing, and points out that, however good the rate-fixer may be, it is essential that the principal himself should take an interest in the work. "His object should be to deserve, win, and retain the confidence and esteem of his workpeople in his honest administration of his system; and, until the time arrives when time setting may have to be done by a highly trained independent expert, jointly appointed and paid by the employers and the workmen, nothing should be allowed to stand in the way of attaining this." The allusion to an "independent expert," foreshadowing, as it does, a solution of one of the most difficult problems in payment by results, which will in all probability be adopted in the period of reconstruction, will not escape the attention of the reader.

In all parts of the volume the author displays a wide sympathy, not only with the desires of workpeople and their employers, but with the great aspirations of the country as a whole. But in no part are his views on these broader aspects of his subject more clearly and more admirably expressed than in his concluding chapter. We should like to reprint every word of it, both to show the nature of Mr. Thomson's views and the cleanness of his literary style; but that is out of the question, and we must content ourselves with a few sentences strung together, as far as may be, in an ordered sequence. "Increased output we must have . . . . but we must see that it is obtained in a proper and legitimate manner and by methods which will stand the test of time. . . . . Both employers and workmen must apply their minds to this fact, that in the future they will have to give better value for the same money than they have done in the past, or the same value for less money. . . . . Higher wages to workmen may be obtained by a raid on the profits of the capitalist . . . . but any impartial investigator, who has given a little time to serious consideration of the average profits obtainable in the shipbuilding and engineering industries during the last ten or fifteen years, will very soon come to the conclusion that no permanent increase in the workmen's wages can be reckoned on from this source. . . . . Through it—the premium system—the men have in their own hands a method of increasing to any reasonable extent the value of their rate of output, and of increasing their wages by a sum much in excess of anything they would get by any possible absorption of the profits of capital. . . . . Premium bonus is, in fact, the best practical form of co-partnery which the workmen could have. It gives them a direct and immediate return on their efforts—they do not have to wait six months or a year for their dividend or profit—it is paid at the end of each week—each receiving an amount in direct proportion to the degree in which he has merited or worked for it. There are no such things as losses to be considered in *their* balance sheet. But all this cannot be obtained without increased output on the part of the workmen themselves, and I shall have fallen very far short indeed of my intentions, if anything I have said should convey the impression that I am in any way seeking to impose upon them a system which would reduce them to the level of human automatic machines, or which would undermine or detract from their individuality. . . . . Apart from the benefit to the workman, I have already indicated how satisfactory it can be made from the employer's point of view, and I can assure any employer who introduces and honestly and sympathetically operates it, and who whole-heartedly determines to make it a success, that he will never have cause to regret having done so. But, of course, it requires to be worked fairly and tactfully in no narrow or selfish manner, and with a due regard to the fact that the employer is dealing with men and not with machines. . . . . Let our employers and workmen alike cast aside that parochial and selfishly narrow outlook which has been such a stumbling-block in the past, and by a lesser suspicion of each other's motives, and a greater appreciation of each other's rights and obligations, sink such differences as they may have in a whole-hearted desire thoroughly to equip themselves for the coming economic battle for industrial supremacy. If they do so, then we shall be able at once to put our country back again into the great industrial position amongst the nations which she once occupied and should never have lost."

We shall be disappointed if this string of quotations fails to convince the readers that Mr. Thomson looks to the premium system for the realisation of high ideals.

We have been led by the fascination of the subject to write at greater length than we intended, but this review would be seriously deficient if we did not refer to the Appendix to the volume. In it is presented an attempt so to modify the Rowan system, that an objection which has been raised against it may be successfully met. It will be recalled that under the system the maximum increase in the rate of wages occurs at the point where the workmen is saving half the time allowed. When this point is passed the increments to the wages decrease at exactly the same rate at which they had increased before, and it has sometimes been contended by employers that the inducement to increased effort is thereby spoiled, and by workmen that they are not treated fairly. As a matter of fact, experience shows that with reasonably good time setting the bonus rarely exceeds the limits between 40 per cent. and 60 per cent. increase—the flatish summit of the curve—and that the defect in the system is rather academic than real; but, nevertheless, Mr. Thomson has thought it worth while to develop a formula which permits the maximum point to be put at any position the manager pleases, whilst retaining the great characteristic of the Rowan system, that under no circumstances can the wages be quite doubled. The formula is naturally a little more complex than the very simple one used for the standard system, but it gives a very clean and neat result, and may appeal to employers who think it advisable to carry the summit of the bonus curve further forward. With these few words about a subject which raises a host of problems, we must conclude this review of a volume which, we feel sure, will be as fully appreciated by progressive employers as it is by us.

BOOKS RECEIVED.

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Naval Architecture. Part I. (Cambridge Technical Series). By J. E. Steele. Cambridge: The University Press. 1917. Price 5s. net.

Logarithms for Beginners. By Charles N. Pickworth. 6th edition. London: Whittaker and Co. and Emmott and Co. Price 1s. 2d. post free.

Prospectus of University Courses in the Municipal School of Technology, Manchester. Session 1917–18. University of Manchester: Faculty of Technology.

Kelly's Directory of the Engineers Iron and Metal and Electrical Trades, 1917. London: Kelly's Directories, Limited, 182–184, High Holborn, W.C. 1. 36s. net.

The Indicator Handbook. Part II. "The Indicator Diagram: Its Analysis and Calculation." 6th edition. London: Whittaker and Co. and Emmott and Co., Limited. Price 3s. net.

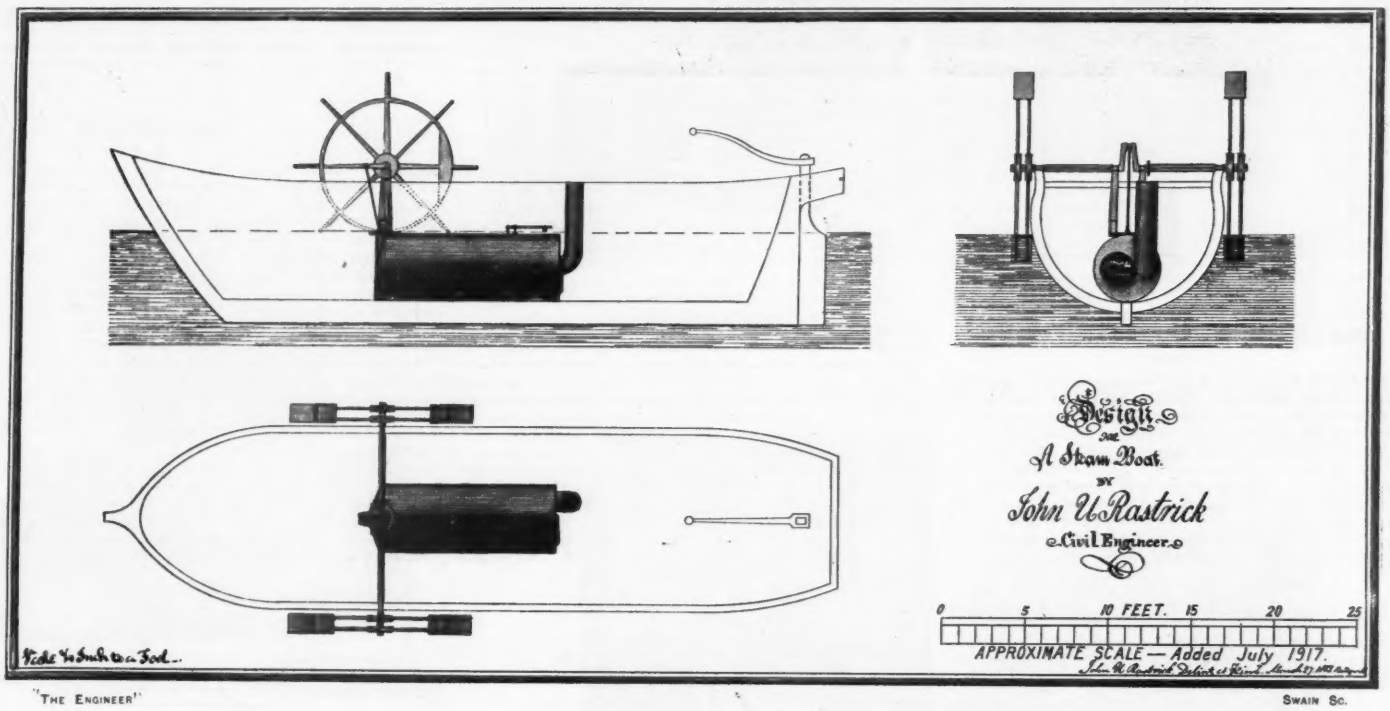
United States Department of the Interior—Bureau of Mines: "Coal Mine Fatalities in the United States, 1916," compiled by Albert H. Fay; Bulletin 128 (Mineral Technology) "Refining and Utilisation of Georgia Kaolins," by Ira. E. Sproat; Technical Paper 137, "Combustion in the Fuel Bed of Hand-fired Furnaces," by Henry Kreisinger, F. K. Ovitz, and C. E. Augustine; Technical Paper 168, "Metal Mine Accidents in the United States During the Calendar Year 1915," compiled by Albert H. Fay. Washington: Government Printing-office, 1917.

THE INDUSTRIAL LEAGUE.

WE have on one or two occasions, notably in a "Random Reflection" on November 24th, 1916, referred to dinner parties given by a little group of men interested in the labour problems of the day. The dinners began in quite a small way by Mr. Lee Murray, Mr. Scholey, Mr. Edgecumbe Brighten, and Mr. Ames, asking one or two Labour leaders, Mr. George Roberts and Mr. Wardle, for examples, to meet them over a modest meal to discuss industrial questions. Such success attended these friendly discussions that soon more and more men expressed their desire to be present, and the number reached forty or fifty, made up of a score or more of men all well known in the Labour world, and others interested in the employers' side of industry. Besides Mr. Wardle and Mr. George Roberts, we have seen Mr. Hodge, Minister for Labour, Mr. Young, Mr. Arthur Pugh, and Mr. Bellamy, to mention a few of those with whom engineers have most to do, around the table, whilst, besides the promoters, there were also present Mr. Blain, of the Underground Railways; Mr. Charles Day, of Manchester; Mr. Gregory, of the B.T.H. Co.; Mr. Dicksee, a master builder of Rugby, who is believed to have had not a little to do with the recent agreement made in the building trade; Mr. P. V. Vernon, of Alfred Herberts, and many another. There was always a lot of good talking, in which the Labour leaders, being bred up to the trade, shone, and there was always that candid talk and free criticism which is only quite possible at a private table—for the Press was never there in its official capacity, and no reports of the opinions expressed found their way to the public.

Such admirable work was done by these friendly meetings under the presidency of Lee Murray, the most genial of hosts, and the most conciliatory of chairmen, and so evident did it become that the industries of the country might benefit by the expansion of the scheme, that it was at length decided, whether wisely or not the issue alone can show, to seek more publicity, and at the same time find funds to carry on the friendly crusade. Hence a larger dinner was arranged, and was held at the Monico last Friday night. Very many of those who have "assisted" at previous dinners were there, and amongst the guests of the evening were Sir Albert Stanley, President of the Board of Trade; Mr. Huth Jackson, whose connection with another organisation having a similar aim will be recalled by our readers; Sir Archibald Denny, Mr. E. W. Petter, and many others known in labour and industrial circles. Mr. Lee Murray was in his usual seat, and opened the evening with a really admirable speech, breathing a spirit of sympathy with the aspirations of Labour, and yet firm upon the real needs of industry. He was followed by Mr. Scholey, who explained to the guests how the meetings had come into existence, and told them that it had now been decided to give the organisation a real corporate existence, under the title of the Industrial League. He also explained that its object was to increase the good feeling between employers and employed by offering them the means of talking over industrial problems under friendly conditions, and that it hoped particularly to reach the small employer. He was followed by the President of the Board of Trade, who, in a carefully considered speech, full of the practical wisdom that can be gained by experience, and by experience alone, put the industrial case before his audience; then Mr. Roberts spoke with the freedom of a Labour leader and a Parliamentary Secretary. Sir Archibald Denny followed with some useful critical remarks and reminiscences of pleasant dealings with his own workpeople—his shrewd observation that "there was too much delegation and too little representation" in the little parties of workpeople who wait upon their employers to discuss difficulties, sticks in our mind as a very happy aphorism. Mr. Huth Jackson then spoke, and was followed by others, so that the clock had turned the bend towards midnight before the meeting broke up, and even then the party segregated into groups that continued the discussion. Altogether a most successful beginning to the new League, and made all the rosier when it was found, a day or two later, that it had resulted in the establishment of a very useful fund to begin further work upon.

We have watched the League from its infancy, before it had a name, and we shall continue to follow its career with interest, for it seems to us that in its endeavours to keep a touch of humanity in the dealings between employers and employed it is moving on lines that lead in the direction of a wider, a better, and a deeper understanding of the full needs of industry. Whether it will be wise if it attempts to develop into an organising body is a matter about which we must confess to some doubt. Its function so far has been to create an atmosphere of good fellowship, and we are disposed to think that it has by no means exhausted the good work that can be done by friendly and informal gatherings over a hospitable board.


Design for A Steam Boat by John U. Rastrick Civil Engineer.
0 5 10 FEET. 15 20 25
APPROXIMATE SCALE — Added July 1917.
"THE ENGINEER"
SWAIN SC.

RASTRICK'S DESIGN FOR A STEAMBOAT

AN EARLY STEAMBOAT.

IN a letter on "Old Books," in our issue of June 29th, Mr. Arthur L. Johnson, of Bolckow, Vaughan and Co., Limited, Middlesbrough, wrote: "I picked up at a country book-shop the large folio volume of plates to Tredgold's Works, dated 1839, London, John Weale, which contained, stuck in a back page, a drawing which must surely be of interest to all engineers, as it is signed by John U. Rastrick, March 27th, 1813, Bridgnorth, and is a plan, sectional elevation and end elevation of a design for a steamboat. The engine is set in the end of the boiler, and is high-pressure, and directly connected to the crank shaft, on which are mounted a pair of paddle-wheels. The workmanship of the draughtsman is admirable, and the shading would probably not be worth the trouble to-day. The picture is of interest, as Rastrick was the founder who built the engines of Richard Trevithick, and it would please me to know if Trevithick ever had such a ship constructed, and if he planned it himself. The scale of the drawing is ½in. to a foot, and the ship was intended to be about 40ft. long, 11ft. 6in. beam, and 5ft. 6in. draught."

Guessing that Mr. Johnson had struck a real treasure, we wrote to him at once on receipt of his letter, and, as a consequence, he has been good enough to have the drawing photographed, and has given us permission to reproduce it. Simple as it is, it is an extraordinarily interesting link in the history of steam navigation. The Trevithick influence is obvious. The engine is a high-pressure one—there is no condenser—and all the complication of side-levers or overhead beams is avoided. The whole design is as direct and simple as could be desired. The cylinder is apparently single acting, and we gather that a trunk piston, with the connecting-rods coupled to a gudgeon pin, was proposed. It is almost buried in the domed end of boiler, which has a fire-flue at one side and a return flue at the other. The counterbalance weights in the paddles will be observed. The whole thing is excellent in its simplicity and directness of purpose.

At our request Mr. Johnson has scaled the drawing with care, and making allowances for the changes in the paper during more than 100 years, he concludes that the original length of the vessel was meant to be 44ft. overall, by 11ft. beam. We have added to the drawing a scale, from which the other dimensions may be taken.

We are quite unable to say whether this "ship," as Mr. Johnson calls it, though pinnace is probably a better name, was ever constructed, and if any of our readers can give any clue to it, we engineers would be greatly indebted to them. Trevithick, as readers of his "Life" know, was deeply interested in steamboats, and in Vol. I., page 352 of his "Life," a letter by him to Hazeldine, Rastrick and Co., Bridgnorth, dated November 13th, 1815, Penzance, may be found. In it he says, "Enclosed you have a drawing for the towing engine for London, which you will execute as soon as possible." It is clear from the context that the engine in question was meant to drive a screw propeller, so that even if it were not two years later than the Rastrick drawing, it would be obvious that the same vessel is not referred to.

It may be of interest to recall that Fulton's steamboat, the Clermont, was completed in 1807, and that John Robertson's "Comet" was built in 1812. Hence Rastrick—or Trevithick—could not be regarded as a pioneer; but it must, at the same time, be admitted that the simplicity of the design, and the obvious intention to use high-pressure steam, are matters of the highest interest. Whilst we fear it is unlikely that any of our readers will be able to throw further light on this most interesting drawing, we feel sure they will be glad to see the reproduction of it. We would not for the world suggest that Mr. Johnson should part with such a treasure, but we venture to suggest to the Museum of Science that it ought to ask him to give it a full-size tracing of the original.

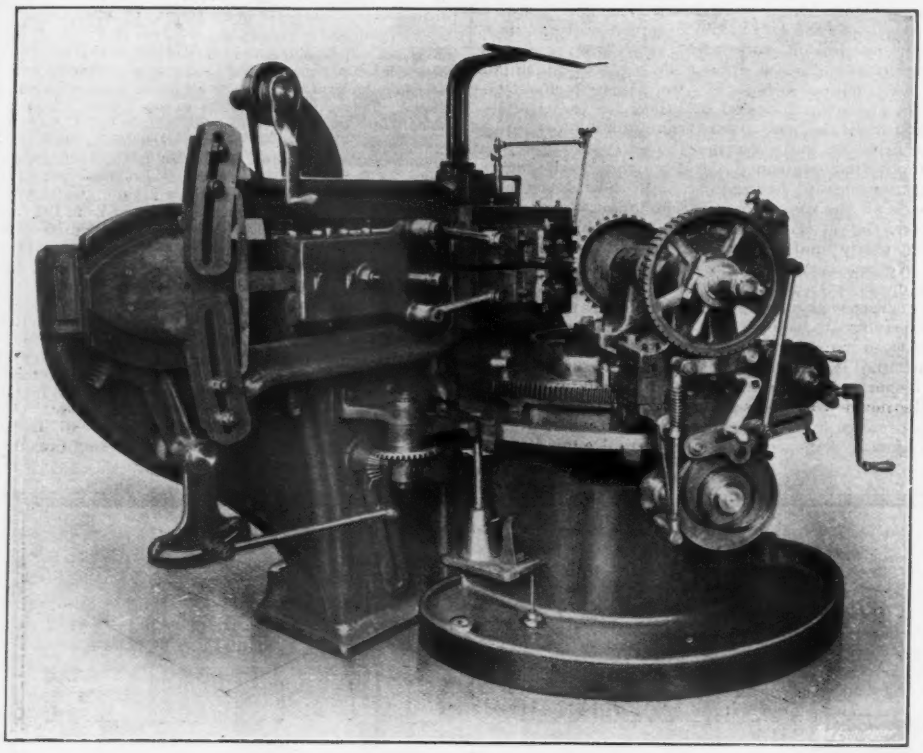
BOOKS OF REFERENCE.

FOLLOWING the example set by numerous British Chambers of Commerce, the Dublin Chamber has just issued a Commercial Year Book. It is framed very much on the lines of the books which have gone before it, and seeing that it has, like them, been printed by Bemrose and Sons, Limited, it is almost superfluous to say that it is well produced. It contains, first of all, lists of officers of the Chamber and of the members, the latter giving also the names of the firms to which they belong, their businesses, and addresses. Following this there is a short preface by the Chairman of the Chamber. Then nearly one hundred and fifty pages are devoted to a review of Dublin. This is divided into four sections, all of which are well written, interesting, and instructive. The four sections are entitled "Historial Sketch"; "Trade and Commerce"; "Industries"; "Education and Research, &c." Finally, there are trade indexes in English, French, Russian, and Spanish, and an illustrated trade mark section.

WE notice one change in the present issue of *Kelly's Directory of Engineers*, and that is that the electrical trades are, for the first time, included in the title which, given in full, is now "Kelly's Directory of Engineers and Iron, Metal and Electrical Trades." This useful book of reference is only published every four years. It appeared first as long ago as 1870 and the present is the thirteenth edition. It is not claimed that there are any new features embodied in the volume now before us, but it is a great thing to have produced the book at all under existing circumstances, and it will doubtless be welcomed by many, for it cannot be denied that a period of four years—short though it be from some points of view—is amply long enough for a work of this character to have got out of date. The book is obtainable from Kelly's Directories, Limited, 182–184, High Holborn, London, W.C. 1, price 36s.

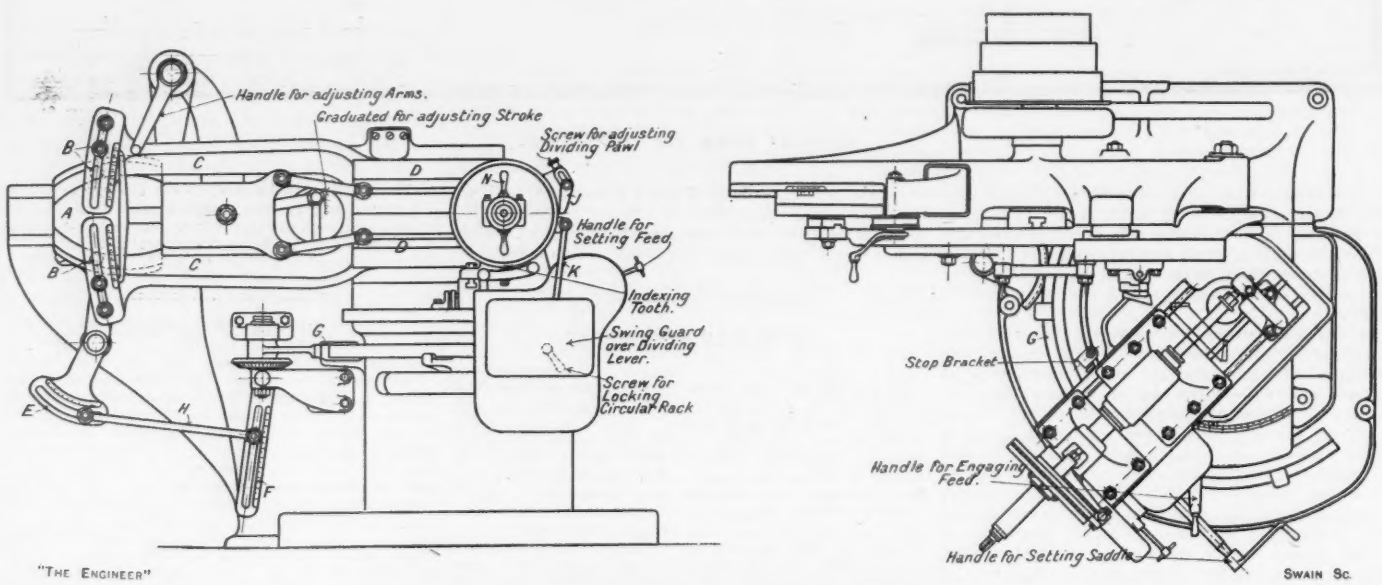
BEVEL GEAR GENERATING MACHINE

SMITH AND COVENTRY, LIMITED, MANCHESTER, ENGINEERS



BEVEL GEAR GENERATING MACHINE.

THE Robey-Smith bevel gear cutting machine has been on the market some years, and has earned for itself a very high reputation. As most mechanical engineers are aware, it works on the generating principle, with two tools operating simultaneously on both sides of a tooth, and the tooth curve is an arc of a circle which is formed on the odontograph principle. The wheel blank is placed upon a spindle which carries the index plate, and is mounted on a saddle that is pivoted at a point on an imaginary line passing through the apex of the pitch cone, the feed being effected by swinging the saddle upon the pivot. The cutting tools are carried in rests which are moved upon slides by means of connecting-rods attached to a crosshead, the latter receiving reciprocating motion from a rod and crank disc. The makers, Smith and Coventry, Limited, of Manchester, have recently improved the machine by providing it with a new generating motion shown in the accompanying illustrations in place of the links, guides and blocks of earlier machines. This comprises a former plate A, shown in the line drawing, in which are cut the curved grooves corresponding to the transverse section of a tooth. In these grooves rollers B, connected to the arms C C, engage, and on the other end of these arms the tool slides D D are fitted. The tool slides are provided with V-shaped bearing surfaces and strips for taking up wear. The plate A is mounted on a slide that is controlled by the quadrant E, which is in turn operated by a rod H from the slotted lever F. This lever is connected to the work saddle by means of the circular rack G and bevel gears, and the movement of the plate A is governed by the action of the rod H on the ever F. The movement of the former or generating plate causes the arms to open as the blank is fed to the tools. At each stroke of the machine the blank is rotated a distance equal to one tooth, and when a cut has been taken off both sides of all the teeth in the wheel blank the work spindle is fed in by the feed mechanism an amount suitable for the next cut by means of the feed motion shown, and so on until the work on the wheel is completed. The dividing mechanism consists of a pawl J, the movement of which is controlled by the relative positions of the connecting-rod end K, in the slotted dividing lever shown in the general view. This lever is so graduated that the connecting-rod can be set to any pitch of teeth. The cam which operates the lever is of the two-revolution type, giving a smooth motion to the dividing pawl. When once the correct dividing plate has been secured on the work spindle sleeve the whole process is automatic. Twenty-one dividing plates are provided with each machine, which is belt-driven by means of a three-step cone pulley, but if desired the machine can be adapted to motor driving through a three-speed gear box. The box and motor base are supplied as a complete unit easily attached to the machine.



ELEVATION AND PLAN OF BEVEL GEAR GENERATING MACHINE

A FIRM of American shipowners has, at a single stroke, converted three 6000-ton steamers to Diesel-engined ships. By so doing the three vessels are now said to be capable of carrying altogether 2400 more tons of cargo than formerly, and their fuel bills are about one-fourth of what they previously were. The engines are of the 6-cylinder type, capable of developing 1700 indicated horse-power.

AN ELECTRICAL METHOD OF HARDENING STEEL.

AN electrical method of hardening steel, known as the Wild-Barfield patented process, has recently been developed and put into practical use at the Westminster Electrical Testing Laboratory, York Mansions, York-street, Westminster, S.W. 1. The process, as demonstrated to us, is remarkable for its simplicity, both as regards the apparatus employed and the manner of carrying it out, and should, we believe, prove particularly attractive in cases where steel has to be hardened by unskilled labour. It is said that water from the river Don used to be exported in barrels to America, because the Sheffield hardeners had found that this water was best suited for quenching purposes. This may or may not be true, but it is certain that in steel hardening practice old customs and prejudices die hard, and even under the stress of present events, have not been entirely swept aside. The Wild-Barfield process may be thought by some to be too revolutionary, for it represents, at first sight at all events, a distinct departure from established methods. On the other hand, satisfactory and convincing evidence has been afforded us that it is viewed with great favour by certain authorities, and that advantage is being taken of it in connection with the difficult problem of keeping up the supply of hardened screw gauges at present in demand.

The process, in so far as it involves the heating of the steel up to a certain point, and quenching it, entails no departure from accepted practice. Its chief claim to distinction may be said to lie in the manner in which the attainment of the correct temperature from which to quench the steel is judged. The furnace shown in the annexed engraving consists of a cylindrical vessel of heat-insulating material, containing a lining A of special composition. Within the lining there is embedded an electrical heating coil, which in use is supplied with direct current. The temperature inside the furnace may reach 850 to 870 deg. Cent., and is measured by means of a thermo-couple. It is not of material importance, however, what precisely the furnace temperature is so long as it is above the temperature from which the steel to be hardened should be quenched. This temperature is that of the decalescence point of the steel in question, and varies from steel to steel. It may be said, however, in general to be round about 750 deg. Cent. The procedure then is simply to suspend the gauge or other body within the furnace until it reaches the decalescence point, and thereupon to remove and quench it.

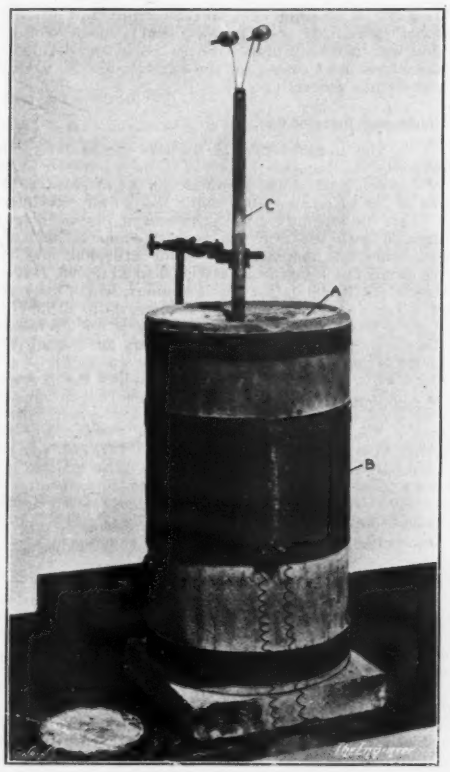
The chief novelty of the process lies in the means adopted for determining when the steel reaches its decalescence point. These means take advantage of the known phenomenon that steel ceases to be magnetic at and above the decalescence point. The heating coil, embedded in the furnace lining, behaves as a solenoid and radiates magnetic flux. As is well known, the magnetic flux from a solenoid is increased by inserting within the coil a core of magnetic metal such as steel or iron. In the ordinary case the coil of an electro-magnet is wound closely round the metallic core. In the present instance the core is the gauge or other body to be hardened, and is separated from the coil by an intervening space—filled with liquid salt—and the enclosing furnace lining. This reduces but does not wholly suppress the influence of the core as regards the increase of the magnetic flux from the solenoid-heating coil.

On the exterior of the furnace a coil of insulated wire, B is wound. The ends of this coil are connected to the terminals of a delicate reflecting galvanometer, the spot of light from which is arranged to move across a scale in the usual way. On inserting the gauge or other body within the furnace the magnetic flux from the heating solenoid is increased. During the actual short period of the increase a condition of affairs arises which is equivalent to the cutting of a magnetic field by the external coil B. A current is thus induced in this coil, and as a result a deflection of the galvanometer spot of light occurs. With the core in position within the solenoid the magnetic flux from the solenoid takes up an increased but steady value, the induced current in the external coil ceases, and the spot of light returns to its zero position. In practical working no attention is paid to the movement of the spot of light at this stage.

As the gauge becomes heated up its influence on the magnetic flux from the heating coil remains practically constant until the decalescence point is reached. At this

point the steel becomes non-magnetic. The loss of its magnetic property extends over a brief period, and so far as the galvanometer is concerned is equivalent to the withdrawal of the core from the solenoid. While the magnetic flux is decreasing a current is induced in the external coil—in the opposite direction to the first induced current—and the spot of light is deflected. Were the gauge now allowed to remain in the furnace the magnetic flux from the heating solenoid would reach a reduced but constant value, no current would be induced in the external coil, and the spot of light would return to the zero position. The second movement of the spot of light is, however, carefully watched for, and as soon as it occurs the gauge is withdrawn and quenched in a bath of liquid salts. Then after it is finally quenched in water, it can be dipped into a bath of hot water, so that when it is set down it may dry of its own accord.

The whole process occupies but a brief time. As demonstrated to us, a 1in. plug screw gauge was heated up to the quenching temperature in 1½ minutes. The rapidity and uniformity of the heating are most important features of the process. Special attention, too, has been paid to the attainment of uniformity in the quenching. As a result, the gauge or other body is hardened to a uniform degree, without distortion and without the formation of scale.



THE WILD-BARFIELD STEEL HARDENING FURNACE]

As to the degree of hardness obtained some results of tests carried out at the National Physical Laboratory for the Hardness Tests Research Committee may be quoted. The steel experimented with was ordinary tool steel, containing 1.5 per cent. carbon. Two specimens were hardened in the usual way by quenching in water, and two others were treated by the Wild-Barfield process, as applied to screw gauges. The scleroscope and resistance-to-abrasion figures for these four specimens were as follows :—

	Scleroscope.	Resistance to abrasion.
Water quenched	81–110	560, 560
Water quenched	78–112	420, 530
Wild-Barfield	68	710, 710
Wild-Barfield	70	710, 560

In connection with these figures it is to be noted that in the opinion of most the scleroscope, whatever property or combination of properties it may precisely measure, does not give a figure which is a just measure of that property which it is desired to confer on steel by "hardening" it. It does not necessarily follow, therefore, that the scleroscope figures quoted above imply that the Wild-Barfield process yields a softer material than the water quenched. On the other hand, the scleroscope figures do establish the fact that water quenching does not give a uniformly treated product ; the figure obtained varies, it will be seen, over a a wide range for different parts of the same specimen. Methods of directly testing resistance to abrasion are not yet wholly satisfactory, and it is quite probable that the figures 420 for the water quenched specimen and 560 for the Wild-Barfield are due to irregularities in the testing machine.

COMBINED SWITCH, WALL SOCKET, AND PLUG.

THE problem of connecting portable electrical apparatus to a permanent source of supply has occupied the thoughts of manufacturers for a number of years, but their principal efforts have been directed towards the production of a convenient, small, and artistic design of wall plug and socket suitable for use in private houses. With the introduction of portable electrical apparatus into factories this problem has assumed more difficult proportions, and with the publications of the Home-office regulations governing the use of electricity in factories, the problem has been still further complicated.

To comply fully with the requirements of the Home-office regulations, and also with the requirements of factory engineers, it has been necessary to design a wall socket and plug which, while being of thoroughly sound mechanical construction, provides that :—

(*a*) The wall socket must be combined with a multipolar switch by means of which the tubular contacts in the socket may be rendered "dead."

(*b*) The plug must be so interlocked with the switch and socket that it is impossible to insert the plug while the switch is "on," and the tubular contacts "live," and it must also be impossible to withdraw the plug unless the tubular contacts are "dead."

(*c*) The multipolar switch must break contact on each pole.

(*d*) The apparatus must be efficiently earthed, and it must be impossible to break the earth unless all the contacts are rendered "dead."

(*e*) The plug having been withdrawn, it must be impossible for anyone to turn the switch on, and thus make the tubular contacts in the socket "live."

(*f*) The apparatus must be so constructed that when necessary it can be rendered absolutely water-tight, and it should also be so constructed that when necessary it can be rendered flame-proof for use in mines.

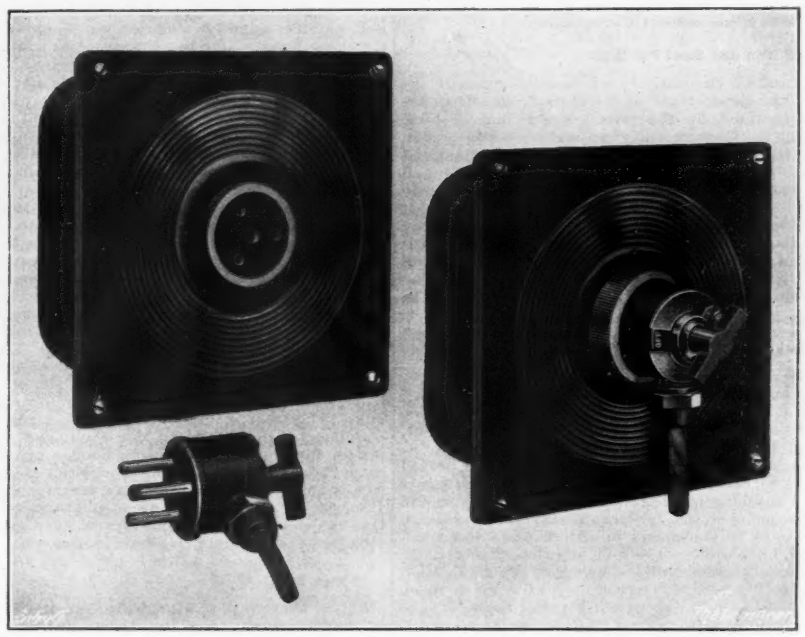
Messrs. Donovan and Co., 47, Cornwall-street, Birmingham, have recently designed, patented, and put on the market a type of wall socket and plug for which they claim that, while combining great mechanical strength, it fulfils all the above requirements. A form of it, which is designed for a three-phase circuit, is shown in the accompanying illustration.

The socket and switch are enclosed in a cast iron case, which can be rendered water-tight and flame-proof. The switch is of the multipolar type acting on each plug contact.

The mere act of inserting the plug does not operate the switch. In the design under notice, the plug is provided with a key which operates the switch by turning to the right or left, and the plug is so arranged that it cannot possibly be withdrawn unless the switch is in the "off" position. The handle shown in the illustration, in the centre of the plug, is attached to a pin which engages in the body of the wall socket and switch. This pin, when turned by means of the handle, operates the switch, and it is so designed that when the switch is in the "on" position it is locked and cannot be withdrawn. This pin is made of hardened steel so as to resist continual wear. The pin being locked in the body of the socket and switch, when the switch is "on" it is impossible to withdraw the plug unless the switch is in the "off" position. Further than this, if the socket and switch were removed from the case and the switch left in the "on" position, the plug could not be inserted, because the locking arrangement inside the body of the switch socket would be in such a position that it would not register with the key or pin in the plug referred to above, and, consequently, this key and also the other parts of the plug could not be inserted.

The switch is of the quick-break rotary type, with an absolutely free handle arranged so that the switch cannot be held in semi or partial contact. The socket is made of a solid block of ebonite, shrouded in a metal case, and the plug also consists of a solid block of ebonite similarly shrouded in metal casing.

The plugs are made for different systems of supply—namely, 2-wire direct current, for which two pins are required, and three-phase alternating current for which three pins are required. Provision is made in each plug for the connection of an earthing wire in addition to the pins ; that is, on the 2-pin plug 3-wire flexible can be used, two of the strands being for connection to the plug pins and one being for connection to the earthing arrangement in the plug. In the same way 4-wire flexible can be used in the 3-pin plug.



COMBINED SWITCH, WALL SOCKET, AND PLUG

THE Mayor of Baltimore has engaged Mr. Bion J. Arnold, of Chicago, as consulting engineer to advise in connection with the extensive plans for improvement by the Pensylvania Railroad. These plans include new tunnels through the city to connect the Pennsylvania main line with a four-track railroad, and the public is asking that electric traction be installed.

CHARGES FOR LONDON WATER.

AT its meeting on the 30th March last, the Metropolitan Water Board resolved that in view of the increasing deficiency in the Water Fund, and the increased sinking fund liabilities which the Board is under statutory obligation to meet six years hence, the Appeal and Assessment Committee should be requested to consider and report as to the steps to be taken to enable the Board to discharge its current liabilities year by year as they arise and as to the propriety of promoting a Bill in the next session of Parliament for the revision of the Board's statutory scales of charges.

The Committee, accordingly, inquired into the matter, and has recently reported to the Board concerning it. Our readers will remember that the position of the Board with regard to meeting any deficiency is regulated by the Metropolis Water Act of 1902, Sec. 15 (2) of which provides as follows :—

> "Any sum required to meet any deficiency in the water fund, whether for satisfying past or future liabilities, in any financial year, shall be apportioned amongst the City of London and the metropolitan boroughs in the County of London, and the municipal boroughs and urban districts outside London, the councils of which are for the time being entitled to be represented on the Water Board, in proportion to the rateable value appearing in the valuation lists in force on the preceding sixth day of April of the hereditaments at that date supplied with water by the Water Board or any metropolitan water company or the council of the urban district of Tottenham or Enfield, in the City and each such borough and district."

The Act of 1902 was a Government measure promoted by the Local Government Board, and the provisions of Clause 15 were only arrived at after considerable discussion and division. The Board's charges are regulated by the provisions of the Metropolitan Water Board (Charges) Act, 1907. These charges are being levied substantially in full ; but the Committee points out that it is possible that increased revenue might be obtained under existing powers in certain cases into the details of which we need not enter. As a matter of fact, we do not think that this increased revenue, if it were decided to obtain it, would entirely wipe out the deficit which goes on increasing year by year.

The Committee, itself, is of opinion that it is probable that there would be an outcry if these charges were imposed, and that it is not impossible that in some cases there might even be a loss, instead of a gain.

The Committee has therefore reported that it would appear that without additional Parliamentary powers the Board is not in a position at present to discharge its current liabilities year by year as they arise.

The question as to the propriety of promoting a Bill in the next session of Parliament for the revision of the Board's statutory scale of charges is discussed by the Committee, which states that an important factor in producing the deficiency is found in the obligation imposed upon the Board by Parliament to supply enormous quantities of water for other than domestic purposes. The price at which this water is supplied is, it appears, quite inadequate to meet the cost of production, having regard to the cost to the Board of the acquisition of the several water companies. When the Board's Charges Bill was before Parliament in 1907, and had passed a Joint Committee of both Houses of Parliament, the House of Commons reduces the scale of charges, provided by the Bill and passed by the Joint Committee, for water for non-domestic purposes. The quantity of water supplied for these purposes is now, says the Committee, very much larger than it was at that time, with the result of still further increasing the deficiencies of the Board. These deficiencies, now being raised by rate, amounting on the present figures to about 1d. in the £, are levied impartially over the whole of the ratepayers within the contributory area represented on the Board.

In order to show that a deficiency on a municipal water undertaking is by no means of an uncommon nature,

the Committee has compiled the following table, which compares the deficiency on the metropolitan water undertaking with the deficiencies on a number of provincial water undertakings.

Place.	Percentage of deficiency to capital expended	How deficiency met: Rate in £
	Per cent.	s. d.
Metropolitan Water Board..	.4	0 1 (.94)
Birmingham	1.1	0 5½
Bury	.4	0 6½
Cardiff	1.1	0 3½
Derby	1.2	0 2½
Halifax	2.2	1 2
Hastings	1.3	0 4
Stockport	1.8	1 1½
Swansea	1.9	0 11
Tynemouth	1.0	0 6
Bacup	3.3	2 4
Harrogate	1.9	1 6
Heywood	.9	1 4½
Middleton	.7	0 11½

In discussing the matter the Committee states that the question of whether the deficiencies of the Board should be met by the imposition of a public water rate or by an increase in the maximum charges, is one upon which very marked difference of opinion exists amongst the members of the Board, and having regard to this difference, and to the disinclination of Parliament to embark upon legislation of a contentious character during the continuance of the war, it is of opinion that it is inexpedient to promote a Bill in the next session of Parliament for the revision of the Board's statutory scale of charges. It thinks, however, that everything possible should be done to expedite the completion of the annual audit of the Board's accounts so that the deficiency may be certified, and the precepts issued at the earliest possible date. If this were done and the authorities notified in the month of July of each year of the probable amount of the deficiency they would be called upon to meet, they could make the necessary provision in their estimates, and by that means the deficiency for each year could be met well within the period of the next.

This question of making up deficiencies in the accounts of the Board has always been a matter for annoyance to the various Local Authorities concerned, and that this annoyance is assuming a more and more acute form is evidenced by the fact that a meeting was recently called to discuss the whole matter.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Finished Iron and Steel Position.

THOUGH the activity of demand remains the predominant characteristic of the market, its effects are largely neutralised by the price control, and in some measure by the Government exactions on excess profits. Ironmasters' operations are circumscribed by raw material limits and the shortage of labour. In practically all branches business is very strong. Small bars are urgently called for. Three-eighths rounds command £16 15s. If there is assurance of delivery, buyers are prepared to pay a substantial premium for special sizes. Puddled iron is being called for in large quantities. It is difficult to find any on the open market. Such business as is going through rules on the basis of £12 5s. Billets realise £13 5s. to £13 10s.

Price Ranges.

Marked bars on 'Change in Birmingham to-day—Thursday—were the old price of £15 10s., less 2½ per cent. basis, Lord Ward's make being £16 2s. 6d., and Messrs. John Bradley and Co.'s bars £16 10s., less 2½ per cent. Unmarked bars this afternoon were without quotable alteration, but had an upward tendency, and this proved to be the strongest branch of the entire market. Merchants demanded anything from £15 5s. and £15 10s. up to £16 and £16 5s. and over, net, for second-class bars of ordinary sizes delivered to consumers in the district, and small bars of ⅜in. basis could not be bought at less than £16 15s. net per ton delivered. Nut and bolt iron was a minimum of £14 5s. to £14 11s. 3d. per ton net, delivered to Black Country consumers. Uncontrolled prices were:—Tube strip, £15 5s. to £15 10s. per ton; hoops—steel and iron—£18 and upwards; and black sheets—doubles—£19 10s. per ton, all net. Galvanised sheets are still subject to limitations, which have brought about such a marked diminution in the output. Neither bars nor spelter are any easier to procure. Ironmasters quote £28 10s. for export for ordinary 24-gauge corrugated, and 5s. more for open-annealed roofing qualities. Black sheets are £19 10s., and £1 5s. extra for painting.

Pig Iron.

More business is being offered than furnace owners are prepared to accept. The full maximum prices are paid. Some uneasiness is manifested at the extent to which production is being drawn upon for the export trade, in which prices are unrestricted. The formal promulgation of the new Order by the Ministry of Munitions, which appeared *in extenso* in last week's ENGINEER, embodying certain rearrangements lately effected with regard to pig iron prices, is regarded in this district as finally disposing of the application of Derbyshire, Northamptonshire, and North Staffordshire smelters for a raising of the maxima in their favour. The official announcement is silent on this subject. It is more significant for what it does not say than for its affirmative aspect. As to the new Order itself, it may be said here that it amounts to very little, for the more important changes in prices and other matters notified have actually taken effect some time. A more elaborate grading of hematite iron is promulgated, and the price limit which formerly applied to basic iron in the Derbyshire, Northamptonshire and North Staffordshire districts is specifically applied to Cleveland and South Staffordshire, viz., 97s. 6d. Beyond this, there is nothing really new in the Order. Current market values are:—Staffordshire all-mine forge iron, 115s.; all-mine foundry at 120s.; warm air forge at 145s.; warm air foundry at 155s.; special quality—Lord Dudley's cylinder—at 167s. 6d.; and cold blast at 182s. 6d. Other prices are:—Northamptonshire, No. 4 forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry, 94s.; basic, 97s. 6d.; Derbyshire, No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; No. 2 foundry, 94s. 6d.; No. 1 foundry, 96s. 6d.; basic, 97s. 6d.

Steel Trade.

There is some talk of plate mills which were recently diverted to the rolling of shell steel being again put on plates, which are needed in much larger quantities than are now forthcoming. Some deals have been effected in American hollow blooms for solid drawn tubes. The price ranges from £33 2s. 6d. to £35 f.a.s. New York. Naturally such rates are only paid in cases of special urgency. Steel scrap is scarce, and the crowded condition of the railways in respect of transport of all sorts checks business. Semi-manufactured steel in the form of blooms and billets was a very unsatisfactory market for users this—Thursday—afternoon in Birmingham, American and British supplies being as restricted as ever, and prices so much "in the air" as to be purely nominal. All the manufactured steel works are full to overflowing with Government orders and other demands of a closely allied character.

Wages Advance.

An advance of 3d. per cwt. has been conceded by the employers to the anchor smiths in the Cradley Heath, Old Hill, and surrounding districts of East Worcestershire, the increase to take effect from August 6th.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

So far as the general condition of the iron, steel and metal markets is concerned, there has not been much obvious change during the week. The output of all sections of the trade is almost all absorbed by Government orders, and it is mainly a question of allocation and distribution, without any price element to create interest

Foundry Iron.

The market here for foundry iron is again very dull, and if it were a free market we should certainly find merchant firms willing to sell forward at considerably less than the spot prices. Sellers of Derbyshire iron still quote 98s. 8d. for No. 3, and Staffordshire is offered at 102s. 6d., both delivered here. Readers will remember that some time ago, at the time when the Cleveland maximum was raised to 92s. 6d., and the question of a change in the Midland maxima was being discussed, sellers of Derbyshire iron inserted a clause in all contracts stipulating that the new maximum was to be charged, if and when it came into operation. As time went on, sellers gradually allowed this clause to fall into disuse, it being assumed that the change would not be made, and the clause being greatly disliked by their customers. This week the clause is being revived, and, of course, suggests that somebody knows something about what the Ministry of Munitions is going to do in the matter of Midland maxima; or it may be that the rise in the steel-making irons has revived memories and stimulated hopes. The demand for foundry iron here is, however, far from being what it was, and even if the legal maxima be put up 5s. per ton it does not follow that the market would respond. It is quite likely that if any attempt were made to compel consumers of Derbyshire foundry iron to pay, say, 103s. 9d. per ton for No. 3, they would, by hook or by crook, obtain some Cleveland iron to be going on with. Scotch foundry iron is quiet at the old prices, say, 128s. for Eglinton, and 129s. 6d. for Glengarnock, when sold here by merchants. One has not heard of Eglinton iron for some time; but, apparently, a little can be obtained here now.

Forge Iron.

There is only a moderate demand for forge iron at the maximum prices, but at the same time the supply is small, and there is no pressure to offer it.

Steel.

There are offers of small lots of American wire rods on the market at £30 per ton, but this is the only steel one hears about. American billets are not mentioned, and the trade in American bolts and nuts seems to have come to an end.

Scrap.

There has, so far, been no revival in the demand for common heavy steel scrap for melting purposes. This demand should come either from Cleveland or from Wales very shortly, because it is incredible that the material is not well worth the limit set upon it by the Ministry of Munitions; and while the pressure for new steel continues, there must be an opening for scrap. If the demand should come both from the North and the South at the same time, any collections here would soon be cleared away; and hence dealers show no anxiety to sell or any inclination to accept less than the full maximum. Heavy steel turnings are still in demand at 50s. per ton, but sellers are not in evidence. It is said that 65s. has been paid for them, but how this is to be reconciled with the regulations it would be difficult to say. The demand for cast scrap has, naturally, fallen away with that for foundry pig iron; for if the foundries are not using so much pig they cannot use the same quantity of scrap. Last week dealers were rather easy in their prices, but they have not receded any further this week, and can probably hold out quite a long time before any one gets into a panic about the future. The accumulation of this class of scrap is not nearly so fast as in ordinary times, partly because machinery is not being broken up and scrapped to the same extent; and partly because, in the absence of labour, it takes longer to break up any particular lot. Hence one does not anticipate any serious slump in foundry scrap prices. Wrought scrap is not offered at the maximum prices, and the market is still waiting for something to be done. There is, of course, a good demand for it.

Metals.

The reduction in the prices for copper was not unexpected after the news which had come from America last week. It is not of much consequence, unless it means that a freer distribution of copper will follow. So far, it has not made much difference to the prices which dealers are asking for good lots of gun-metal and heavy yellow brass; but one notices that dealers are offering considerably less when they are buying these metals. English ingot tin was quoted on the Manchester Exchange at £244. Lead was not quoted.

The Tramway Workers' Dispute.

The application of the Manchester tramway workers for the variation of the previous award by the Committee of Production having failed in its object, namely, to obtain a further advance in wages of 7s. 6d. per week, a meeting of the Lancashire and Cheshire District Council of the Tramway and Vehicle Workers' Union was held on Monday last, when it was decided to make a fresh application for the advance for the workers in the county generally.

Increased Price of Gas.

The annual report of the Gas Committee of the Manchester Corporation, which is to be submitted to the City Council next week, recommends an increase in the price of gas of 6d. per 1000 cubic feet to all consumers. Although the income for the past year shows an increase compared with the previous year of some £67,000, the expenditure has increased by about £108,000, and the gross profit has fallen from £190,000 to £149,000, leaving a deficit of £34,000 in last year's account, which has to be met. The committee has also to contribute £50,000 in aid of the city rate, and a further sum of £61,000 is needed for a sinking fund for the redemption of loans. The amount of gas sold during the past year was 5,561,137,000 cubic feet, a decrease of 2.44 per cent. on the previous year's figures. The cost of coal and oil per ton, carbonised, shows a substantial increase over that of the year before, namely, 18s. 1.39d., as against 14s. 9.60d., and the income from residual products rose to 12.571d. per ton as compared with 10s. 0.10d. per ton. The effect of the Summer Time Act has been to decrease the consumption by 110,000,000 cubic feet, or 1.80 per cent. of the annual consumption.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a very busy state of things in the hematite pig iron trade all through this district, and from present appearances, this is likely to be the case for a long time to come. The demand for iron is very heavy and shows no signs of easing off, the position being rather the other way. Makers on their part are doing their best to meet the heavy requirements of users, but they have not as yet been able to increase their output any further. There are thirty furnaces in blast, and other furnaces are in various states of readiness for work. Prices are steady at the maximum rates of 126s. 6d. per ton f.o.t. Special brands are at 140s. per ton.

Iron Ore.

The demand for iron ore is heavy. Local smelters are pressing hard for big deliveries, and it is hoped a much heavier tonnage of metal will be available in the immediate future. There is plenty of ore in existing mines for an increased output, and at the same time attention is being given to widening the sources of supply, not only in Furness but in Cumberland. The demand for foreign ores is steady.

Steel.

Steel makers are particularly busy. The demand for billets and other semi-products is brisk, not only on local, but also on general home account, and good outputs are being maintained. The steel foundries are also busy, but some of the finished steel branches of the trade are quiet. The work in hand is wholly on material for national uses, private users' requirements having to stand aside. Prices are firm, with heavy rails at £10 17s. 6d. to £11 10s.; light rails, £14 to £14 10s.; heavy tram rails, £14; billets, £12; ship plates, £11 10s.; boiler plates, £12 10s. per ton.

Fuel.

There is a keen demand for steam coal, which is at 25s. to 27s. 6d. per ton delivered from Lancashire or Yorkshire pits. Cumberland sorts run a shade less. House coal is in quiet demand at 27s. 6d. to 37s. 6d. per ton delivered. For coke the request is brisk, and East Coast qualities are at 33s. to 35s. 6d. per ton delivered, and Lancashire cokes are at 31s. per ton delivered.

SHEFFIELD.

(From our own Correspondent.)

Employment of Discharged Soldiers.

A BY no means unimportant aspect of the question of industrial reconstruction is the replacing in positions of usefulness in civil life of men discharged from military duties. The number of these men who have done their best as soldiers must now be very high, seeing that almost 130,000 have already registered their names at various Labour Exchanges. They know what discipline and hardness and sacrifice mean, and to that extent many of them are better men, though more or less broken in health. The need for more definiteness in the handling

of this question was pointed out in THE ENGINEER some time ago, and since then there seems to have been greater attention given to the matter. In Sheffield it has recently been taken up with earnestness, and good and profitable results are anticipated. In many instances firms have kept in touch with men who have left them for service with the colours, and in such cases there is little difficulty; but often the pre-war occupation of discharged soldiers was of a casual, or, at any rate, unskilled nature. These are the men who, if their physical condition permit, should be trained—given a belated apprenticeship—in some occupation demanding skill, and now, when the demand for skilled men is great, is the most opportune time to do it. In this way, and, remembering the natural absorption taking place in regard to men who have kept in touch with their former employers, a definite commencement is being made in the work of reconstructing the ranks of industry, and at the same time a new outlook of hope is given to those who might presently, when the rush of returning troops begins at the termination of the war, have been pushed aside, perhaps almost forgotten. The facilities and opportunities in Sheffield are so good that it is thought better for the city to make its own arrangements than to form part of a county scheme. It is regarded as a pressing problem, and I believe is being taken up in the right spirit. The leading steel firms may be quite relied upon to do their part in the matter, and the Sheffield University has already established a department for training men, thus co-operating with the local Naval and Military War Pensions Committee, which has the support also of the Labour Exchange and other district authorities.

Works Chemists.

I do not know how the recently formed Metallurgical Chemists' Union is progressing. Perhaps it has been dropped. Its inaugural meeting, I remember, was marked by a grumble about wages, and a desire that some step should be taken to level them up. But there are steel "chemists" and steel chemists, and if the former want to get the best out of the profession they have chosen they should try a levelling up process in their own particular cases, as regards ability, so that they become something more than mere automata in a laboratory. The facilities available to them at the University are unsurpassed, and the steel industry stands on the threshold of a new era, wherein production will be more than ever upon scientific lines. This is clearly indicated, as I mentioned in a previous letter, by the number of new laboratories now coming into existence. But a laboratory is of little use without a strong, intelligent *personnel*, and the present opportunity calls for a special effort, so that our staff of steel works' chemists may be equal or superior to any on the Continent or in America.

Electrodes for Furnaces.

The move in future will be very largely toward a development of steel melting by electric furnaces. One can almost see the disappearance of crucible furnaces, and if the newer system had only been established a little sooner production of all kinds of special steels would have been greatly facilitated now, when, for the want of skilled men like teemers and pullers-out, there are crucible furnaces actually standing idle, whilst high-speed steel supplies cannot overtake the demand. Speaking of the growth in the number of electric furnaces now in operation, one of the difficulties appears to be the supply of electrodes. Something of this was foreseen about a couple of years ago, when, it may be remembered, a combine of local steel firms was formed for the purpose of manufacturing carbon for electrodes used in electric furnaces, and so protect shareholders from the irregularities of an uncertain market. We had been receiving these things from Germany, America, and Sweden, but principally the first-named, so that the formation of this combine meant the capture of another key industry, for without the electrodes the new furnace installations could not proceed. Vickers, John Brown, Thomas Firths, Hadfields, Kayser Ellisons, and Osborns were the principal members of the combine, and all are represented on the directorate, the company being floated for £40,000 in £1 shares. The present scarcity, however, makes it appear desirable that the operations of the combination should be extended.

Piece or Datal?

An important decision was given on Tuesday by Sir William Clegg in the Munitions Tribunal here. The case was one in which a moulder asked for compensation for wrongful dismissal from one of the largest steel works. The point hinged upon whether the firm had a right to transfer the man from datal to piecework, and as the employers' and workmen's assessors could not come to an agreement, Sir William, as president of the court, had to decide. It appeared that prior to June 11th the man had been doing a certain class of work for which he had been paid datal wages. He was then ordered to do piecework, declined it, was paid up, and given his leaving certificate. The contention of the Moulders' Union representative was that none of its members, according to rule, were allowed to work otherwise than at datal rates after they had reached the age of twenty-one years. The Union, therefore, contended that the man was justified in refusing to work, as it was not a lawful order. The employers' argument was that the shop in which the man worked was known as an "open shop," and was not within the jurisdiction of the Union. Unionists and non-unionists were employed in the shop. In 1906 a dispute occurred on the same point, and the men refrained from work. When they resumed, it was on the understanding that datal rates would not necessarily obtain in that particular shop, and ever since it had been the firm's custom to pay both datal and piecework rates. The conclusion Sir William Clegg came to was, that the contract of the firm required the men to work datal or piece, and in the present case the man was bound by that contract. The firm was entitled to dismiss him for disobeying lawful orders. He therefore found that the man was not entitled to compensation, and the application was dismissed.

Round the Works.

The extraordinary activity in mercantile shipbuilding is reflected in this district, not only by the urgent call for steel castings and forgings, but for all kinds of tools. Makers of files cannot possibly produce fast enough, and such is the demand for twist drills, that in the absence of sufficient men, women are being trained to do certain parts of the work. Engineers' small tools are in very strong request, and makers of "tank" steel and aeroplane parts are extremely active, as are also those of boilers and hydraulic presses. Steel wire is much in demand, and large quantities of steel helmets are being turned out. The rolling mills are working at high pressure, and in view of a probable long run of activity after the war most of these firms are making what preparations they can for extensions. One has just announced its purchase of five acres of land for development purposes. Government orders are still pouring in, the latest tenders asked for by the War-office specifying for 18,000 small table-knives, 15,000 awl blades, 1,200,000 helmet tops and ventilators, 5000 screw turners, 4000 butchers' cleavers, 1500 weed hoes, 1000 bread knives, and 25,000 metal water bottles. Oversea business maintains a fair level, but, of course, becomes every week more difficult. The enormous boom anticipated in house building after the war—a commencement will, it is hoped, be made before that date—is good news for makers of stove grates, sanitary fittings, and builders' general light foundry work. This branch of trade has long been depressed, but preparations are now being made to meet the coming demand. Information has reached Sheffield from Derby to the effect that in all probability a large new works will be erected there shortly. No details are yet to hand, but negotiations are proceeding with the Corporation, and it is understood that a considerable extension of the Corporation's electricity works will be necessary.

Iron, Steel, and Coal.

There appears to be little change in the iron market locally in any direction. Even the recent announcement by the Ministry of Munitions regarding the extension of maximum prices, so as to cover hematite malleable irons having no particular significance, because for some weeks past the trade had been working to the figures now officially mentioned. The supplies of East Coast hematite and special low phosphorus qualities from the West Coast, are being delivered fairly well for war production purposes, and the values of all irons are very firm on the official maxima, with still no sign of an increase in Derbyshire. The figures for Swedish material c.i.f., quoted in my letter last week, were very much too low. The pre-war price was approximately £12 10s. per ton delivered, and I said that this had risen to £45. That price, however, relates to f.o.b. Gothenburg, the c.i.f. figure ranging from £60 to £65 per ton. The output of local acid steel is very heavy, and is under continual expansion, but the crucible production is hindered somewhat by want of more skilled men, the consequence being that a number of melting holes are standing. In the fuel market the chief topic is the coming into operation of the Coal Controller's new regulations as to transport. The Sheffield district is a large buyer of Derbyshire and Nottinghamshire coal for household purposes, but these contracts will be automatically cancelled as from 6 p.m. on September 8th. Where special brands of coal have been coming into Yorkshire from outside districts for manufacturing purposes, licences for the continuance of the supply may be obtained. Otherwise, Yorkshire's needs will have to be met from within. Collieries, however, will find plenty of markets provided for them by the Controller in other parts of the country. The appointment of Mr. Maurice Deacon, one of the directors of the Sheepbridge group of collieries, and a mining authority of high standing in the country, to the honorary position of technical adviser to the British Government, in association with the French Ministry of Mines, with regard to the recovery of the collieries destroyed by the Germans in the Lens district, is considered a very good one. For the moment the steam coal market keeps steady under a full demand, with little on the open market, and exports to neutrals practically nil, but with a fair amount going to Allies and large quantities taken by the Government. Gas fuels are being put on the ground in heavier lots, and there is a good inquiry about for spot. Nuts are in heavy demand and slacks are steady. Coke is firm. House coals are very strong. Best South Yorkshire steam hards are quoted 18s. to 18s. 3d.; Derbyshire 1s. less, with seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 17s.; washed smalls, 13s. to 13s. 6d.; best hard slacks, 12s. 6d. to 13s.; soft nutty slacks, 12s. to 12s. 3d.; pea slacks, 10s. 6d. to 11s. In house sorts, branch is quoted 21s. 6d. to 22s. 6d., and best Silkstone 18s. 6d. to 19s. 6d., all per ton at pit.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE briskness industrially in the Cleveland pig iron trade is well maintained. In the home section deliveries are reported to be proceeding very smoothly under the supervision of the local Control Committee. There being no scarcity of iron, makers are fully prepared to meet all the orders, and the noticeable improvement in the truck position has greatly facilitated dispatch. The allocations of foundry iron for the home trade are expected in the latter part of the week. In the meantime the market is quiet, although the position continues very firm and steady. Business during July has been on the dull side, but, notwithstanding the Tees-side annual holidays next month, a substantial revival is looked for in August. Applications are likely to be heavier, particularly for Scotland, where the holiday period is at an end. Moreover, during the last few days, shipments have been heavier, the tonnage arrivals having shown a decided improvement. This has facilitated exports to the Allies, whose demands for foundry iron are continuously heavy. Prices are firmly held at the current maximum rates. No. 3 Cleveland pig is 92s. 6d., No. 1 96s. 6d., and No. 4 foundry and No. 4 forge each 92s. 6d. The f.o.b. export quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

On every hand there is marked activity in the hematite pig iron trade on the North-East Coast. The requirements of makers of munitions of war continue to be very heavy, and promise to be even heavier in the future. While the position still continues somewhat stringent, there is no anxiety with regard to home supplies, which are adequate. But the recent temporary reduction in output referred to last week is reflected in the export department, a number of June allocations for iron already licensed having had to be cut down. Fair shipments, nevertheless, continue to be made under contracts entered into during the first half of the year. Merchants are shipping this iron at the old rate, subject to any readjustment officially determined. The home maximum price of East Coast mixed numbers stands at 122s. 6d., and the export f.o.b. quotations are nominal at 137s. 6d. to France, and 142s. 6d. to Italy.

Iron-making Materials.

Deliveries of foreign ore are more satisfactory, and a steady though hand-to-mouth business is being done as tonnage facilities permit. Adequate supplies of coke are coming to hand. Furnace kinds of good medium quality realise around 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

In the steel-making industry the prevailing note is still one of ceaseless activity. The entire industry is dominated by the circumstances of the war, and, as has been the case for some considerable time past, the whole production is used directly or indirectly for war purposes, leaving little or nothing for private home consumption, and even less for export. The manufactured iron trade, too, continues to run at the highest possible pressure, the heavy demands of the Government having considerably tightened up the sources of supply. Although the output has continued on an exceptionally large scale it has not been possible to divert any material into other channels, with the result that ordinary business is at a standstill. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export: Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ¾in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 3/16in., £16; ¼in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles and joists, packing iron, and iron bars.

Scrap.

There are few new features of interest in the scrap trade. As has been the case for some weeks past, supplies of all that is required are exceedingly short, and it is difficult even to deal with the requirements of users who have special claims on merchants. So far as heavy wrought scrap and steel turnings are concerned, the position still remains unsatisfactory. Business is almost at a standstill, merchants contending that the limit of price is far too low. It seems almost certain that these sections of the trade will have to wait until the position has been considered by the authorities, and the prices revised. The demand for foundry scrap has fallen off during the past two or three weeks, and few transactions have been recorded. Prices are unchanged, with steel scrap, heavy melting, at £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, ¾in. thick and over, £6 5s.; heavy wrought iron scrap, ¼in. thick and over, £5 5s.

The Coal Trade.

The coal market is dull and without any immediate prospect of improvement. It cannot be denied that the effect of the new export regulations and prices issued by the Controller of Mines has been thoroughly to unsettle the trade. Several difficulties have arisen, first, with regard to the classification in some instances; second, as regards the prices which for certain classes have been advanced; and third, regarding the one-third of 5 per cent. brokerage which has to be paid to the collieries, and about which there is still much confusion. Until foreign buyers grasp the new prices and conditions little neutral business may be expected, and it is only in neutral business that merchants have any latitude in quoting prices, the new scale being fixed for the home and Allied markets, but being the minimum for neutral shipment. In view of this unsettled state sales have fallen off considerably, and the collieries have suffered much loss of time, being worse in this respect than at any time of the war period. Thus the position is very unsatisfactory at the moment. The new prices are, of course, maintained in all cases for shipment, though holders of coal have been selling to merchants at below scale figures, a proceeding, however, which must now stop, according to the reported decision of the Coal Controller. How holders are going to get rid of their contract quantities presents a difficult problem, for the whole tendency of shippers, if they have to pay the full scale prices, will be to purchase direct from the collieries, and leave second-hand coal alone. The new Coal Transport Order has as yet had no appreciable effect on the market, for the reason that it does not come into operation before September 10th. When it comes into force, however, it promises to curtail the home trade of the two Northern counties the areas of delivery of which have been much restricted. Quotations are as follows:—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export;

best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. 6d. North Northumberland smalls, 20s.; seconds, 18s. 6d. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; best, 25s.; superior, 30s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

Steel Workers' Wages Increased.

The North of England Iron and Steel Manufacturers' Association has intimated to the National Amalgamated Union of Labour that its members concerned are to be given a further war bonus of 3s. a week, in addition to that of 6s. given on 1st April last. The increase will date from August 1st.

SCOTLAND.

(From our own Correspondent.)

Continued Quietness.

ALL branches of industry are still under the holiday influence, and it may be the end of the week before a full resumption is made. Those manufacturers not directly engaged on Government work are overhauling plants and extending their workshops against eventualities.

Pig Iron.

The holiday season has played havoc with the regular flow of business, and things are not yet as they were. Beyond the necessities of war there is little movement. Shipments, too, are only possible to Allied countries. Prices are all firm.

Quotations.

Monkland and Carnbroe, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

Conditions in the various departments of the finished steel and iron trades are still rather slack, and a few days will yet elapse before a full restart is accomplished. Government demands are still very pressing, and material for the construction of mercantile boats is also in urgent request. All prices remain strong, and higher quotations may be looked for. Nothing of any consequence is now being done outside of Government work, ordinary consumers finding it quite impossible to secure supplies of any description.

Coal.

As in other departments of industry, the quietness in the coal trade has been accentuated by the holidays. Miners in the West of Scotland have been on holiday, and the resumption is very slow. Quotations are unchanged. Best ells are, f.o.b. at Glasgow, 26s. 6d. to 28s.; splints, 28s. to 30s.; navigation, 25s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. In the Lothians district there is still a lack of business all round, and collieries are suffering a considerable amount of broken time. Best steams, f.o.b., at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. In Fifeshire, as in the Lothians, prospects are dull. First-class screened navigation are quoted, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s. per ton. The aggregate shipments from Scottish ports during the past week amounted to 148,232 tons, compared with 163,779 in the preceding week, and 221,508 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Miners for France.

MR. J. D. MORGAN, who with Mr. Daniel Davies has made a tour of inspection in France, and consulted French miners respecting the proposal to take over Welsh anthracite miners to work in French coal mines, has given on his return a report of his visit. The headquarters of the collieries in the Briey district were visited, where 20,000 colliers were engaged. He expresses the opinion that the leading collieries were all laid out in such a way as to reduce manual labour to a minimum. The company proposed that the first batch of miners from this country should be 100, and after these men had had experience extending over a few weeks, another batch of 500 should go over. The average earnings at this colliery came to 8s. 9d. per day. They had reason to believe the British Government would provide food free, because the French wages were lower than the pay in this country. The collieries were worked with safety lamps of French type, though no gas had been found. The ventilation was good, and no coal dust was found in the roadways. The haulage on the main roads was done by electric locomotive engines. Compensation on the British scale would be paid the workmen, and a working arrangement had been made between the Miners' Federation of Great Britain and the French Federation. The men worked on a nine-hour system, starting at 5 a.m. and finishing at 2 p.m.; and this was followed by an afternoon shift of nine hours.

Linking up Power.

At a recent meeting of the Cardiff Electrical and Tramways Committee, the manager and engineer submitted a report showing the preliminary work which had been done in South Wales and Monmouthshire, in relation to the national movement for linking up the various electrical generating stations in the country for effecting economies in the supply of electricity. For purposes of compiling information, South Wales and Monmouthshire had been divided into three districts, one embracing Swansea, Llanelly and Neath, the second embracing Pontypridd and the Rhondda district, and the third representing the areas supplied by Cardiff and Newport and the immediate vicinity supplied by the South Wales Electrical Power Company. In order that the work of the committee, so constituted, might be carried a stage further, the manager and engineer—Mr. Arthur Ellis—asked for the authority of the committee to go more closely into details, with a view to preparing an estimate covering the costs of the cables necessary for the purpose of linking up and other details relating to the advantages, if any, to be derived from so doing. The committee empowered Mr. Ellis to proceed with the matter. In view of the probable developments of Cardiff, and the fact that application had been received from the Windsor Slipway, owned by Messrs. Elliot and Jeffrey, ship repairers, &c., for a supply of electrical power, Mr. Ellis recommended an extension of cables which would involve a cost of between £6000 and £7000. It was proposed at the Windsor Slipway to take energy which would develop 1000 horse-power, the annual consumption approaching one million units. The Committee decided to recommend the Council to adopt the suggestion, and if sanctioned by the authorities, to instruct the town clerk to take steps to obtain the necessary loan.

Current Business.

Operations on the coal market during the past week have been at a very low ebb, the chief difficulty of collieries and exporters generally being the shortage of transport facilities. Lower grade coals have suffered very materially, and work in the coalfield has been very irregular. Stocks of coal have been very heavy, particularly as regards smalls, and dry smalls especially have been difficult to dispose of. The decision of the miners to take three days at August Bank holiday will come as a relief to colliery owners; but it is doubtful whether even this rest will enable many collieries effectively to reduce stocks. Prices ruling have been those according to schedule. Patent fuel has been quiet at round about 30s., while pitwood, though not by any means substantial in quantity, remains at 60s. to 62s. 6d., difficulties regarding wagons being pronounced.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. Coke, 47s. 6d.; pitwood, ex ship, 60s. to 62s. 6d.

LATER.

The coal market continues to show very inanimate conditions, the volume of business actually arranged being small. Pitwood, owing to the difficulty of securing wagons, is rather easier in tone, though quotations still range about 60s. to 62s. 6d.

Pilots' Earnings.

At an inquiry held at Port Talbot on Tuesday, by Mr. Garnham Roper, Assistant Secretary of the Board of Trade, concerning an application made by the Dock, Wharf and Riverside Workers' Union, on behalf of the pilots, for authorisation of a by-law to increase the pilotage rates of the port by 25 per cent. by way of war bonus, some remarkable figures were given concerning the earnings of the pilots. It was stated that there were ten pilots at the port, and their total income in 1913 was £5930. Their contribution to the upkeep of the cutter, paid to another company, was 25 per cent. of their earnings, and in 1913 their contributions were £1847. In 1916 the aggregate income of the pilots was £7790, and the 25 per cent. contributions realised £1999. In the course of the inquiry, Mr. W. W. Jones—Cardiff and Bristol Channel Shipowners' Association, which opposed the application—said that his information was that in 1913 each of the pilots earned £593, and, in addition, each pilot earned £83 as his share of the tonnage rates; that in 1915 each pilot's share was £76, and in 1916 £147. He contrasted the earnings of the Port Talbot men with those of London pilots, who were quite content with £300 a year; at Sunderland the incomes, with bonus, were just over £200, and at Gloucester the pilots got £120.

Newport.

The market has been rather on the idle side, and only a few deals have been concluded in respect of prompt parcels. No forward business is being arranged. House coals meet with a good demand, but otherwise operations are very restricted. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 23s.; seconds, 21s. 6d. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s.; pitwood, ex ship, 60s. to 62s. 6d.

Swansea.

The trade in anthracite coals has displayed no improvement, large, culm and duff being slow, though a steady inquiry prevails for machine-made descriptions. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine-made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 10s. 6d. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, 25s.; smalls, 19s. Bituminous coal: No. 3 Rhondda through, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates, &c.

Business in the tin-plate trade is very unsettled. The Ministry of Munitions has fixed maximum basis prices for tin-plates and terne plates. Makers being well booked, are disposed to await developments. Fresh regulations concerning the manufacture and dealings in tin, terne and black plate are of a more drastic character. The unrestricted sale of certain sizes and substances allowed in April last is now cancelled, but permission is given to dispose of such unrestricted stocks which are now on hand, and for the home trade only, until August 31st, after which date this concession is withdrawn. Nominally, prices are strong at about 36s. to 37s. for 14 × 20 × 112 sheets under Class A certificates. Quotations:—Block tin, £238 10s. per ton cash; £235 15s. per ton three months; copper, £125 per ton cash; £124 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

CHESTER HYDRO-ELECTRIC POWER DEVELOPMENTS.

IN view of the general appeal for the conservation of the nation's fuel supplies, the steady increase in the cost of coal and oil, and shortage of labour, the time is opportune for investigating other natural sources of energy. In this respect the possibility of deriving cheap power from our rivers and streams presents itself in a more favourable light now than it has ever done. When compared with the huge hydraulic power plants of Canada, or of Sweden and Italy, the opportunities in this direction in these islands of course appear insignificance; but their importance increases in accordance with the price of fuel and labour, and there must be many sources of water power, hitherto untapped, which it is quite feasible to utilise in the light of what has been achieved on the river Dee, at Chester. With a fall of 2ft. or 3ft. of water and tides to contend against the hydro-electric power plant which was brought into use by this ancient city some three and a-half years ago, thanks to the resourcefulness of Mr. S. E. Britton, the city electrical engineer, has amply justified its existence. Last year alone more than two million Board of Trade units of electricity were obtained by the Chester plant at an inclusive cost of less than ¼d. per unit, and altogether some six million units have been generated at a cost of .087d. per unit for wages, repairs, maintenance, rent, rates, and taxes. This plant, with the aid of batteries for the peak load, now practically supplies one half of the current consumed in Chester. It presents a fine example of what can be done even with small heads of water.

The success which has attended the Chester plant has induced the Chester Town Council to apply for a grant of £200, under the Development Fund Act of 1909, for the purposes of investigating the power possibilities of the river above Chester with a view to the generation of electricity for the use of the farming and rural industries which exist along the banks of the river. It is proposed for this purpose to utilise about forty miles of the river. On this length there is a fall of 170ft., and assuming that it is possible to produce by water power 10,000,000 Board of Trade units per annum at a cost of ¼d. per unit and obtain an average selling price of 2d. per unit, the balance of income over expenditure capitalised at 15 per cent. would provide for a capital expenditure of £400,000, which is much more than is likely to be needed for the erection of wiers and some ten or twelve turbine plants. It is calculated that enough energy would be available from power now running to waste for the use of 2000 farms, and would result in a saving of 20,000 tons of coal per annum. Nor, judging from the experience already gained at Chester, is any injury likely to be inflicted on the salmon fishing industry. In one particular respect these up-river generating plants would have a decided advantage over that at Chester, inasmuch as their working would not be interfered with by the tides. The output of the Chester plant has recently been increased by some 20 per cent. by the raising of the weir by 1ft. The work was carried out in the early spring at a trifling expense, and the effect upon the river has been beneficial in all respects. More water is maintained in the river for boating, pollution by the tidal water has decreased, and there has been no increase in the flooding.

The project for the development of the power of the Dee is due to Mr. Britton, and it is to be hoped that the Treasury will lend the small financial assistance asked for making the necessary investigations into the practicability of the scheme—which may prove to possess greater economic advantages than are presented at first sight, as well as an incentive to other engineers to survey the hydraulic resources in other parts of these islands.

IRON PRICES.

THE following notice has been issued by the Press Bureau. The Notice (C. 4581) issued to the Press on July 16th contained the following:—

Hematite Pig Iron—Malleable.

	Per ton net f.o.t. Makers' works. £ s. d.
Refined—	
Refined cupola cast	8 0 0
Refined cupola cast to guaranteed analysis	8 5 0
Cast direct from blast-furnaces—	
Small pig iron—all grades	7 10 0
Medium pig iron—white to grey mottled	7 5 0
Medium pig iron—all other qualities	6 17 6
Large pig iron—all grades	6 17 6

The Ministry of Munitions have noticed that, in some of the newspapers, this table has been printed in a misleading manner. All the prices for both "Refined" and "Cast Direct" come under the *one* heading of "Hematite Pig Iron—Malleable." In some of the newspapers, however, only the first two lines of the table were included under this heading, and the remaining four lines were given under a separate paragraph, thereby implying that this latter group of four prices does not relate to malleable quality.

As this mistake has caused considerable confusion, and has led to many inquiries, the Ministry of Munitions would be much obliged if the Press would set the matter right.

IRON MINES OF CUMBERLAND AND LANCASTER.

UNDER Regulation 9 GG of the Defence of the Realm Regulations the Minister of Munitions has power to take possession of any metalliferous mines, or of any mines of stratified ironstone, not being coal mines, and being now of opinion that, for securing the public safety and the defence of the realm, it is expedient that the said regulation should be applied to all iron ore mines in the counties of Cumberland and Lancaster, in the exercise of his powers under the said regulation, and all other powers enabling him in that behalf, has ordered that from and after the 24th day of July, 1917, and until further notice Regulation 9 GG of the Defence of the Realm Regulations shall be applied to all iron ore mines in the counties of Cumberland and Lancaster.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FILING PAPERS.

SIR,—I am very sorry to have overlooked your "Random Reflection" on "Filing Papers," in THE ENGINEER for March 16th, 1917, page 251, which contains a reply to my question why there is not more uniformity in the sizes of periodicals. But the fact that "Large pages are of advantage when illustrations are concerned and are convenient when rapid printing and circulation are necessary," as you say, has not prevented changes to a smaller size by several American technical periodicals, as referred to in my letter of April 21st, published in THE ENGINEER for May 18th, 1917, page 443. As for illustrations, I note that out of a total of about 1000 illustrations in the text, and over fifty on plates contained in Volume 121 of THE ENGINEER, only nineteen exceed the size of 12in. by 9in., and it would seem very much preferable to have them all printed in the text. What you suggest for the publications of societies is in line with the suggestions of the International Institute of Bibliography, and would be of very great help. On this subject may I add the following remarks?

Many engineering societies, both in England and America, issue "Preprints" of their papers in advance of their meetings, either quite separate, often without any numbering, or in publications bearing a different title from the final issue, which is published some time later. These preprints are reproduced and referred to by periodicals, but in many cases a library has only the final issue, and the locating of a paper by means of those references is not very easy. If it is considered impossible to issue the papers in the final form only, like, for instance, the "Philosophical Transactions" of the Royal Society, could it not be possible to issue the "Preprints" under the same name of the final issue and number them in a way that would be maintained? This should not cause any greater expense for the society, while the issue of a single edition might mean a saving. Another objectionable practice of some societies is to reprint the last page of an issue in the next.

A. FANTI,
Librarian,
July 6th. U.S. Bureau of Standards.

COAL ECONOMY.

SIR,—In your issue of the 13th inst. a letter from Mr. W. H. Casmey, on the question of coal economy, forms very interesting reading. Most engineers will not dispute his figures of the quantity of coal that might be saved, if better combustion were ensured by taking as the criterion the CO_2 product.

His statements concerning the saving of coal by reducing the grate area will, however, require more proof to convince fuel consumers that such an alteration would not seriously reduce the evaporation. It is a recognised fact that for good combustion a definite relation must exist between the air supplied and the coal burnt. Consequently, where the demand for steam is constant, there is a definite size of grate area with a given draught, to give the best results. But such is not the case when the demand fluctuates enormously, as in bleach and dye works, where rapid steam raising is essential. To my mind, shortening the grate in such cases is absurd, and I am convinced would be detrimental.

It seems reasonable to believe that if Mr. Casmey's assertions are correct, then the boilermakers in this country must have had their eyes closed the last fifty years.

It would also be of interest to learn why the boiler insurance companies do not advise clients to adopt shorter grates.

LANCASTRIAN.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W.

ORDERS

For the week, by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Platoon Commander P. Bowden.

Monday, July 30th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, July 31st.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, August 1st.—Drill and Elementary Bridge Construction, No. 1 Company, Left Half Company.

Thursday, August 2nd.—Drill and Elementary Bridge Construction, No. 2 Company, Left Half Company. Ambulance Class.

Friday, August 3rd.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Saturday, August 4th, to August 12th.—CAMP.—A camp will be held at Esher from August 4th to 12th. Billets will be provided at Claremont Park. Men will be provided with railway warrants and rations. This expense will be borne by the Government in the case of men in Sections A and B. Others will be required to pay cost price, but not exceeding 4s. 6d. per diem. Volunteers must take with them their own blankets and personal kit in a regulation kit-bag marked with name, rank, company, and regimental number, also enamel mess plate and mug, and knife, spoon and fork. An extra pair of boots is advisable. Parade at Waterloo, opposite No. 10 platform, on Saturday, August 4th, 2 p.m.

Headquarters.—Headquarters at Balderton-street closed August 4th to 12th. Headquarters will be transferred to Claremont Park, Esher, for that period.

Holiday Addresses.—These must be given in to the Orderly Room without fail.

Armlets.—These must be worn at all plain clothes parades.

Musketry.—For all Companies, see notice at headquarters.

Note.—Unless otherwise indicated, all drills will take place at headquarters.

By order,
MACLEOD YEARSLEY,
July 28th, 1917. Company Commander and Adjutant.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

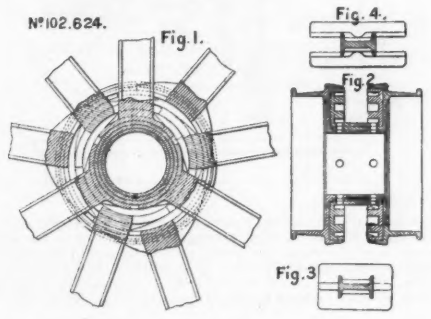
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

102,624 (17,704 of 1916). December 8th, 1916.—MULTI-CYLINDER RADIAL MOTORS, Société des Moteurs Salmson (Systeme Canton-Unne), 9, Avenue des Moulinlaux, Billancourt, Seine, France.

This invention is for a connecting arrangement for the crank-pin ends of the connecting-rods of the pistons of a multi-cylinder motor with radially arranged cylinders. The connecting-rods—which are all arranged in the same plane at equal angular distances around the driving shaft—are divided into several groups, each comprising an equal number of connecting-rods. In each group, each rod at its end intended to be connected

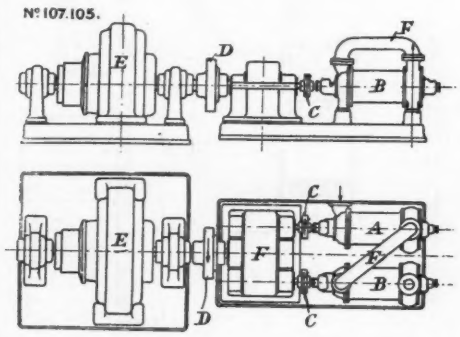


to the driving shaft terminates in a part annular collar, the ends of the annular collar formed by the several part annular collars engaging two corresponding annular grooves in the opposite faces of two discs mounted on the crank of the driving shaft with the interposition of ball bearings by preference. To each group of connecting-rods there corresponds a pair of annular grooves, all these grooves being made concentrically in the opposite faces of the discs, and slots are formed in all the part collars, excepting the part collars nearest to the driving shaft, to permit of the passage of the rods corresponding to the other collars. The arrangement is shown in the accompanying drawings, Figs. 1–4.—*June 21st*, 1917.

TURBINE MACHINERY.

107,105 (10,690 of 1916). July 28th, 1916.—TURBINE PUMPS, Bernard Wiesengrund, West Drayton, Middlesex.

For high-lift pumps, according to this invention two pump units are arranged side by side as at A B, each unit being connected by means of a flexible coupling C or other suitable

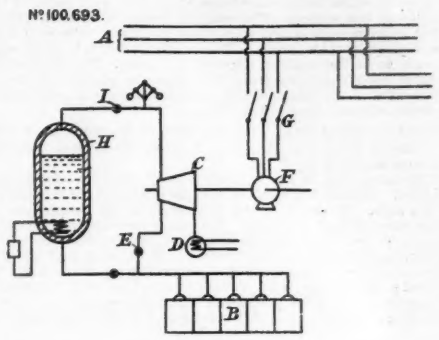


means to the pinion of a speed increasing gear F, the wheel of which engages both pinions. The wheel shaft is connected by means of a flexible coupling D to the driving motor E. The series connection between the two pumps is made by means of a pipe F.—*June 21st*, 1917.

TRANSMISSION OF POWER.

100,693 (8474 of 1916). June 15th, 1916.—STEAM POWER PLANT, Johannes Carl Ruths, 54, Malmskillnadsgatan, Stockholm.

This invention is for a steam power plant for use in electric generating systems, in which a reservoir in connection with the steam reserve plant and containing water under pressure and at a temperature corresponding thereto, is charged by means of steam from the reserve boiler battery and is capable during a breakdown or other disturbance of supplying sufficient motive fluid to drive the reserve steam motors only until the disturbance or lack of power ceases or until the reserve boilers are ready for use. A indicates the three electric power mains from a power station; for instance, a water power station. B is the reserve boiler battery, C the reserve machine which may be a turbine, D the corresponding condenser, E a valve and F an alternating current generator, which by means of the switch G may be connected with the mains A. An insulated reservoir H, containing water under pressure and at a corresponding temperature, is arranged in such a manner in the plant that the turbine C or steam engine, in case of a disturbance or interruption, at first may be driven with steam from this reservoir. The capacity of the reservoir H is preferably so calculated that during a small or short disturbance the total volume of steam required may be supplied from the reservoir, whilst if a greater or longer disturbance takes place which necessitates the employment of spare boiler battery, the steam supply may be supplied from the reservoir until such time as the spare boiler or battery of spare boilers is capable of supplying the steam. In case of a disturbance in the main station or on the mains A or if the energy supply is entirely cut off, the valve I is opened automatically or by hand, so that steam flows from the reservoir H into the turbine C. The generator F then takes over the entire power supply, the network being fed from the generator. If the disturbance is of only short duration, then it is not necessary to heat the boiler B, but if the disturbance is of long duration

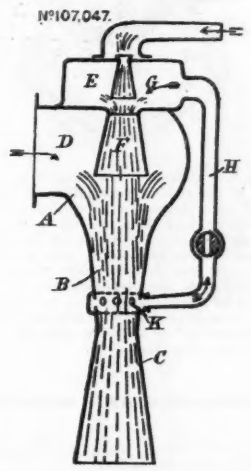


the boiler battery B is heated. As soon as the necessary steam can be supplied from the boilers, the valve I is closed and the valve E opened, the turbine C is then driven only with steam supplied from the boiler reserve B. Other contingencies are provided for.—*June 15th*, 1917.

CONDENSERS AND FEED-WATER HEATERS.

107,047 (8226 of 1916).—June 10th, 1916.—EJECTORS FOR CONDENSERS, Arthur Edwin Leigh Scanes, Strathfield, Harborough-road, Ashton-on-Mersey.

The object of this invention is to provide an improved elastic fluid operated ejector by providing means which will reduce or check the expansion of the operating fluid passing through a portion or portions of the nozzle of the ejector during the starting period, but will allow the operating fluid to expand to the full extent for which the nozzle is designed during the normal operation of the ejector, that is to say, when the pressures corresponding to the normal ratio of compression of the ejector has been established. The expansion of the fluid passing through the expanding nozzle or nozzles of the ejector is reduced

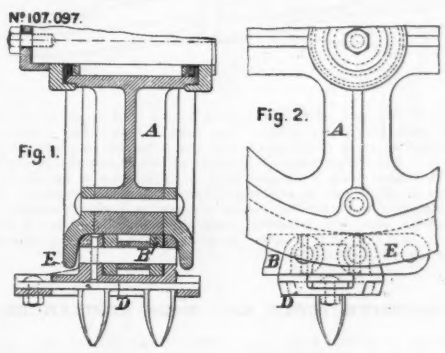


by admitting additional elastic fluid to the nozzle at one or more intermediate points along its or their length, the pressure of the additional fluid so admitted being approximately equal to or greater than that to which the operating fluid normally expands at the point or points in the nozzle or nozzles at which the additional fluid is admitted. Preferably the pressure of the elastic fluid admitted to the expanding nozzle or nozzles is varied automatically in accordance with the pressure obtaining at a predetermined point or points in the converging or diverging portion of the mixing cone of the ejector. Fig. 1 shows one form of ejector constructed according to this invention comprising a suction chamber A, a mixing cone B, diffuser C, air and gas port D. E and F are ports of the divided expansion nozzle, the space between which opens into G connected by the passage H to the point at K as shown.—*June 11th*, 1917.

MOTOR CARS AND ROAD TRAFFIC.

107,097 (9856 of 1916). July 13th, 1916.—CATERPILLAR TRACTOR WHEELS, William Edward Martin, Rock House, Scotgate, Stamford.

The invention is illustrated in the drawings, in which Fig. 1 is a section of part of a chain guiding wheel and chain of a motor

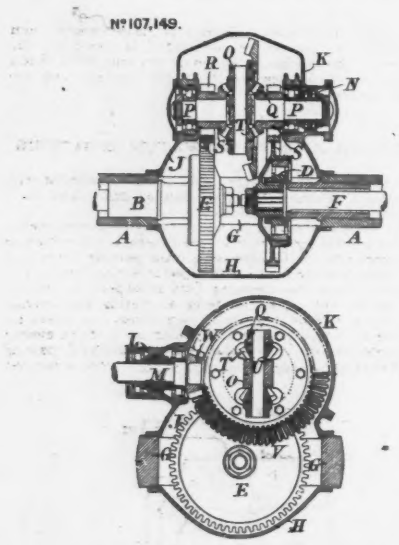


tractor, motor plough or other device driven by an endless chain running on the ground; Fig. 2 is a side elevation of the same. The inventor employs grooved wheels A to carry the weight of the machine and to guide the endless chains B. The flanges forming the sides of the groove

in the periphery of each wheel may be formed as separate pieces which are riveted or bolted, as in other constructions, to the main portion of the wheel. The outer links B of the chain, which, in some constructions, form parts of the pads D carrying the weight, are rounded upon their outer edges where they come in contact with parts of the grooves in the wheels. The central portion C of each groove is flat in cross section and runs upon the upper surface of both sets of the links of the chain. This central portion C at its ends is made to fit the rounded edges of the links. The sides of the grooves flare outwards from the chain to provide clearance at the sides of the chain, and the peripheral edges E are rounded in cross section.—*June 21st*, 1917.

107,149 (15,224 of 1916). October 26th 1916.—DRIVING AXLES, Albion Motor Car Company, Limited, Scotstoun, Renfrew, and another.

This invention is for a "live" back axle for commercial vehicles. Sleeves B are forced into the inner ends of the tubes A of the axle. Mounted on the inner ends of the sleeves are the inner races of ball bearings, the outer races of which engage flanges D on the bevel pinions E of the final drive, which pinions are fixed upon the inner ends of the driving shafts F. The axle tubes A are extensions of the ring forging G forming the central portion of the axle. A case H provided with lubricating arrangements is secured beneath this forging, and above it is secured a case J provided with a housing L for the rear end of the

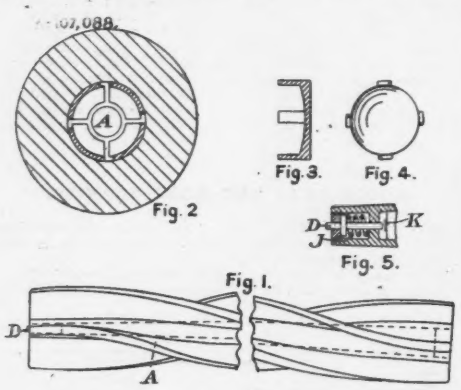


propeller shaft M. Bolted to the case J is a second case K with bearings N for the intermediate and differential shaft. The differential gear consists of a central member O having lateral stub-axles P which form the differential shaft. On the axles P are loose sleeves Q on which are formed pinions R of the final reduction train and which gear with the final drive pinions E. On the sleeves Q are also the central pinions S of the differential gear, the planetary pinions T of which are mounted in apertures in O and carried on a long pin U. The bevel wheel V by which the drive is transmitted from the bevel pinion W on the end of the propeller shaft M is bolted directly to the member O.—*June 21st*, 1917.

ORDNANCE AND ARMOUR.

107,088 (9431 of 1916). July 4th, 1916.—PROJECTILE FOR FIRING THROUGH WATER, Alexander Hubbard, 98, Leigham Court-road, Streatham, London, S.W.

Fig. 1 is an elevation of the projectile made in accordance with this invention, Fig. 2 is a cross section of a gun barrel with the projectile inside, Figs. 3 and 4 views of an obturator used in firing the projectile, and Fig. 5 is a section of the forward end of the projectile showing the firing means. The projectile consists of a cylinder A which tapers towards the forward end

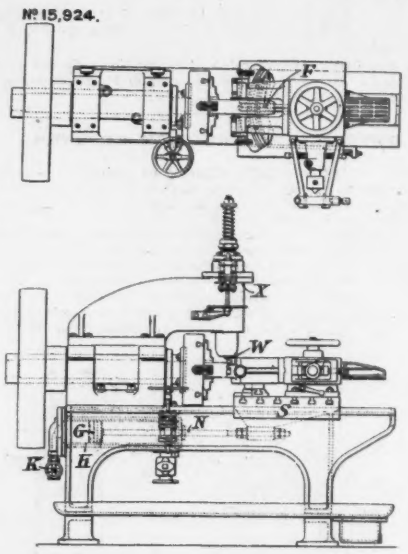


and is provided with four helical blades bent so as to obtain the best propelling effect. The core contains the explosive charge which is detonated when the projectile strikes a solid body. For the purpose of effecting such detonation the projectile is provided with a suitable form of firing pin or needle D—Fig. 5. The pin is prevented from being operated by the pressure of the water by means of a spring J, the resistance of which is overcome, however, when the projectile strikes a solid body, and the pin D is caused to detonate the cap K and explode the charge.—*June 21st*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

15,924 of 1915. June 12th, 1916.—COMBINED BORING AND TURNING MACHINE, William Littlejohn Philip, Strathavon, Melksham, Wilts.

In this machine the saddle S carrying the boring tool F from a station on the turret is secured to a ram G fluid tight in the cylinder H, forming part of the frame of the machine, and in combination with this cylinder means are provided for admitting a hydraulic or elastic fluid to act as a feed medium for the tool F. The return movement of the ram may be effected by a weight or spring or by making the ram double acting by admitting pressure medium to the cylinder through the valve or connection K, and in order to ensure the desired extent of feed for the purpose of giving the necessary accuracy, a stop or stops may be provided upon the ram spindle or rod N, so that the feed will

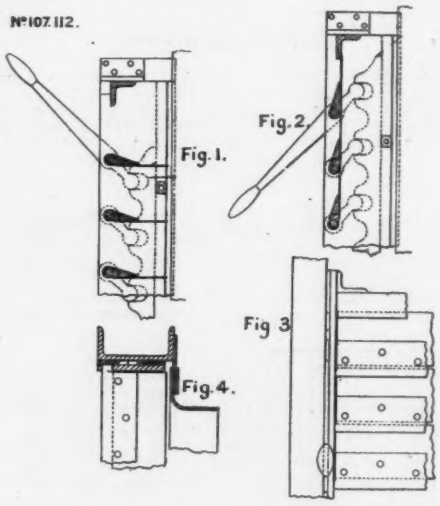


be arrested when the stop comes into contact with the end of the cylinder H, and no damage will be done either to the work or to the machine even should the operator allow the machine to remain running with the feed on for more than the proper length of time. For parting off the tool W is operated in a similar manner by the overhead hydraulic gear X.—*June 12th*, 1917.

MISCELLANEOUS.

107,112 (11,794 of 1916). August 19th, 1916.—FANS FOR FORCED DRAUGHT, Richard William Allen, Queen's Engineering Works, Bedford.

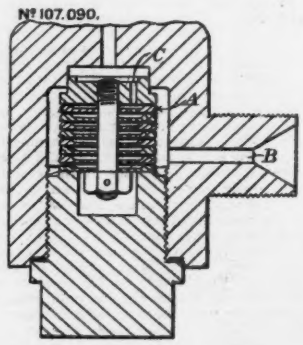
The inventor states that the hinged doors or loose covers fitted to the suction branches of fans on board ship are unsatisfactory and inefficient. He proposes to replace them by means of a number of slots operated simultaneously by means of a connecting bar or bars as shown in the illustrations. A lever



is attached to the pivot of each slot and the ends of the levers are all attached to a connecting bar, at the end of which is an operating lever and handle. The slots are preferably of streamline section built up in the different ways shown, so that when the shutter is closed the end of one slot engages with the adjacent slot and makes an air-tight connection. Fig. 1 shows the shutter open, Fig. 2 and 3 show the same closed, and Fig. 4 a sectional detail.—*June 21st*, 1917.

107,090 (9665 of 1916). July 8th, 1916.—OIL STRAINER. Vickers Limited, Broadway, Westminster, and others.

This straining device consists of a series of metal plates or



discs A clamped face to face to form a pile, very narrow channels or fine grooves formed between the plates leading from the periphery to a communicating channel or channels traversing the pile. The pile of plates is secured in an outer casing having an inlet B leading to a small chamber surrounding the pile, the plates being formed with a series of perforations, leading to a discharge opening C in a thick perforated disc secured in the casing at the outlet, to which disc the plates are firmly clamped by a screwed stud. The end plate is left unperforated so as to close the pile and allow the liquid to flow inwardly under pressure through the fine straining channels into the communicating channels formed by the perforations and thence to the outlet at one end of the pile. The perforated plates may be separated by very thin distance plates of cross or other suitable shape, which form narrow channels at the edge of the pile leading to the communicating channels or perforations. The pile of plates may be secured in the casing chamber by a screw plug bearing upon one end of the pile and provided with packing to ensure a liquid tight joint. The strainer is especially designed for working at high pressures, the arrangement of plates withstanding very great liquid pressure without danger of distortion or injury by collapse of any part.—*June 21st*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of six of the patents given below £26, *and on each of the remainder* £18 *have been paid in renewal fees.*

No. 19,267/10.—Submarine mines. Relates to submarine mines provided with an automatic anchoring device and consists in the employment of a single coupling for locking the drum, the anchor, and the hydrostatic device which serves to stop the mine at the required depth. Bichel, G. E., Germany. Dated September 30th, 1909.

No. 19,268/10.—Submarine mines. Relates to automatically anchored submarine contact mines, and consists mainly in inserting between the cable and the mine, springs or counterweights, which, when deflected by the tension in the cable, close a switch to arm the mine. Bichel, C. E., Germany. Dated December 14th, 1909.

No. 19,398/10.—Ordnance; recoil apparatus. Relates to fluid pressure brakes for ordnance of the type in which the length of recoil is automatically regulated in accordance with the elevation at which the gun is fired, and consists in rotating the adjustable part of the brake by means of a grooved guide connected to a slide which is mounted so as to move longitudinally in the slide carrier. Krupp Akt.-Ges., F., Germany. Dated December 31st, 1909.

No. 19,407/10.—Velocipedes, &c. Back-pedalling brake and free-wheel arrangements. In a free-wheel and back-pedalling brake mechanism for velocipedes, &c., wherein the guide ring or cage of the driving clutch is used to apply the brake, the cage is connected by a ratchet or other one-way clutch to a sleeve having cam surfaces whereby rollers are pressed outwards to expand an anchored brake sleeve into contact with the hub. Sachs, E., Germany. Dated August 28th, 1909.

No. 19,435/10.—Oil presses. A cage for an oil press, in which prismatic cakes are formed, consists of a number of segmental ribbed or channelled parts held together by bands, forming a support or jacket for perforated strainer plates. The plates are fixed to the jacket by bolts, which can be unfastened from outside. Koeber, G., and Koeber, R., Germany.

No. 19,500/10.—Thermostatic fluid regulators. A thin metal packing sleeve for a piston-rod operating the valve of a fluid regulator, such as a thermostat, steam-trap, feed-water apparatus, or water level regulator, has deep corrugations of nearly circular section. Sandvoss, C., Germany.

No. 19,553/10.—Glass manufacture; rolling. In rolling plate glass for mirrors, the table is divided by transverse bars into a number of separate small tables, and the rolled glass plate is subdivided as the rolling proceeds into smaller pieces. The separate pieces are removed laterally into the annealing oven, and subsequently ground, &c., as usual. The separate tables may be water-cooled. Bicheroux, M., Germany.

No. 19,609/10.—Valves; check valves. A check valve for pumps, of the type comprising a springy metal strip stretched over the valve seat, is arranged under a curved stop plate. The strip is freely held in the casing at two points, triangular recesses being provided to permit the end portion to bend while preventing vertical or endlong movement. Meyer, R., Germany. Dated September 4th, 1909.

No. 19,942/10.—Motor vehicles, ploughs, &c. In motor vehicles, ploughs, &c., a casing for the gear wheels which are mounted on the driving wheel is provided with oppositely inclined deflector rings to give additional protection against the admission of earth, dust, &c. Stock, R., Berlin. Dated September 30th, 1909.

No. 20,526/10.—Typewriters; electric type wheel actions; case shift mechanism. In machines in which the keys close electric circuits for rotating and swinging a type wheel and the circuits are broken independently of the keys, the breaking action is initiated before, and completed independently of, the completion of the printing movement of the type wheel; rotation is completed just before impression. For this purpose, the keys set contact retaining slides, levers, or the like, which are independently actuated for breaking the circuits and may serve also as the stops for limiting the rotation of the type wheel. Fischer, O., Berlin.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Staveley Coal and Iron Company, Limited, of Chesterfield, asks us to state that, owing to the taking over of Caxton House, Tothill-street, Westminster, by the Government, its London office has been removed to 5 and 7, Old Queen-street, Westminster, S.W. 1, for the period of the war.

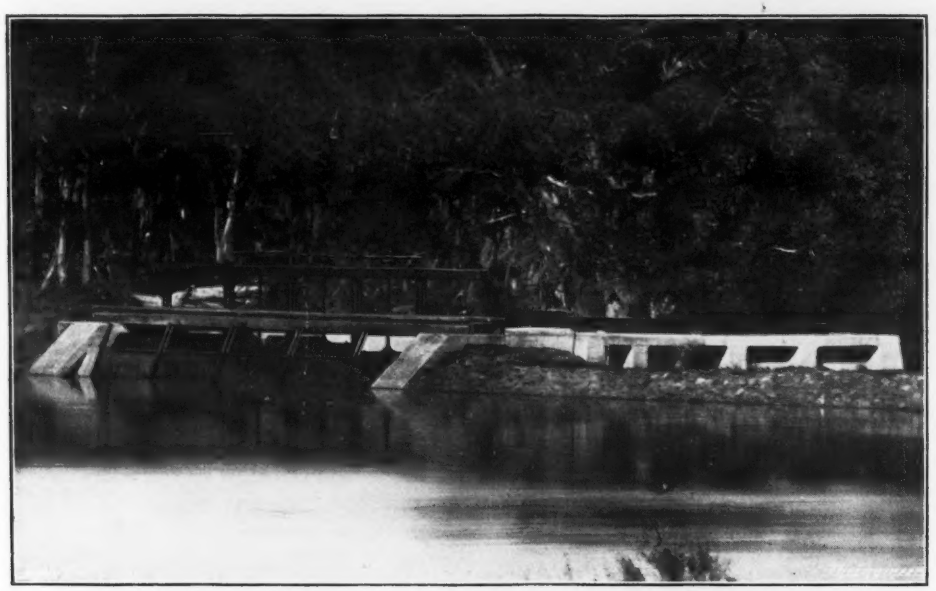
WE are asked to state that Palace Chambers having been requisitioned by the Government for the accommodation of the staff of the Ministry of Food, we beg to advise you that the firm of C. P. Sandberg has taken new offices at Princes' Mansions, 70, Victoria-street, Westminster, London, S.W. 1, which will be its address from 1st August until further notice. The telegraphic address and telephone number will remain as before, *i.e.*, Sandberg, Parl, London, and Victoria 4788 respectively.

THE GREAT LAKE HYDRO-ELECTRIC POWER SCHEME, TASMANIA

INTAKE WORKS AT HEAD OF CANAL—FLOOD TIME

THE DAM AT GREAT LAKE

THE INTAKE



PENSTOCK CHAMBER AND DAM FROM THE LAGOON

JUNCTION OF WOODEN AND STEEL PIPES, SHOWING AUTOMATIC CONTROLLING VALVES

PENSTOCK CHAMBER, SHOWING WOODEN PIPE LINE

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The Engineer.

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VOL. CXXIV.—No. 3214] LONDON: FRIDAY EVENING, AUGUST 3, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

TO MANUFACTURERS ONLY.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS for the SUPPLY of COLD WATER PIPES and ACCESSORIES during a period of six months from date of acceptance of Tender.

Forms of Tender, conditions of contract, and all particulars may be obtained on application to the Controller of Supplies, H.M. Office of Works, &c., King Charles-street, Westminster, London, S.W. 1.

The Commissioners do not bind themselves to accept the lowest or any Tender.

Tenders must be delivered before 11 a.m. on Thursday, 9th August, 1917, addressed to THE SECRETARY, H.M. Office of Works, &c., Storey's-gate, London, S.W. 1, and endorsed "Tender for Cold Water Pipes, &c." 351

H.M. Office of Works, &c.,
31st July, 1917.

Draughtsman and Tech- NICAL INSTRUCTOR REQUIRED for the Gold Coast Government Railway for two tours of twelve months' service, with possible extension. Salary £350-£10-£400 per annum. Free quarters and first-class passages. Literal leave in England on full salary. Candidates who are capable mechanical draughtsmen, having sound technical knowledge of locomotives and machinery and ability to instruct and deliver lectures to apprentices, &c., should apply at once (by letter) to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1. Men engaged on Government work or eligible for the Army will not be considered. 360 A

PATENTS AND DESIGNS ACTS, 1907-1914.
TELEPHONE EXCHANGE SYSTEMS.

The Proprietor of British Let- TERS Patent No. 20,011 of 1913 is prepared to SELL the Patent or to LICENSE British Manufacturers to work under it. It consists in the provision of speech reproducing apparatus which speaks designations of called lines to selected switching operators.

Address, BOULT, WADE and TENNANT,
111 and 112, Hatton-garden,
London, E.C. 1.
370 B

UNIVERSITY OF DURHAM.

Armstrong College, Newcastle- UPON-TYNE.

PRINCIPAL: W. H. HADOW, M.A., D.Mus., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—
F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

University of Birmingham.

DEPARTMENT OF METALLURGY.

PROFESSOR: THOMAS TURNER, M.Sc., A.R.S.M., F.I.C.
LECTURER IN METALLOGRAPHY: (Vacant).
ASSISTANT LECTURER AND DEMONSTRATOR: R. M. JONES, M.Sc.

The course of study covers three years, and leads to the degree of B.Sc. in Metallurgy. There are separate courses for Metallurgists and Metallurgical Chemists. Special attention is devoted to Iron and Steel; Copper, Brass and Local Industries; and to preparation for Colonial and Foreign posts. Research and other Scholarships.—For particulars apply to GEO. H. MORLEY, Secretary. 150 I

University of Manchester.

FACULTY OF SCIENCE.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Full particulars of the Courses will be forwarded on application to the REGISTRAR.
The SESSION COMMENCES on the 4TH OCTOBER. 319

Manchester Corporation Water- WORKS.

The Waterworks Committee invite TENDERS for the Supply and Erection of Two electrically-driven TURBO-PUMPS, with automatic control and switch gears, pipes, valves, &c.

Specification and form of Tender can be obtained on application to the Secretary, Water Department, Town Hall, Manchester.

Tenders, endorsed "Tenders for Turbo-Pumps, &c.," and addressed to the Chairman of the Waterworks Committee, to be forwarded not later than the 18th August, 1917.

By Order,
THOMAS HUDSON,
Town Clerk.
Town Hall, Manchester, 30th July, 1917. 348

City of Birmingham.
ELECTRIC SUPPLY DEPARTMENT.
APPOINTMENT OF ASSISTANT CONSTRUCTIONAL ENGINEER.

An ASSISTANT CONSTRUCTIONAL ENGINEER is REQUIRED to assist in the preparation of specifications and plans for new buildings and lay-out of new steam and electrical plant, and in superintending the erection and testing of such plant.

He should be familiar with the latest practice as applied to large generating stations and should preferably have had workshop, central station and drawing-office experience.

Forms of application, which may be obtained from the Secretary of the Electric Supply Department, 14, Dale End, Birmingham, must be filled in by the applicant, stating salary required, and accompanied by copies of not more than three testimonials as to experience, ability and character.

These should be sent to the undersigned by August 25th, 1917.
R. A. CHATTOCK,
City Electrical Engineer.
14, Dale End, Birmingham. 324 A

Oxford City Waterworks.
WASTE INSPECTOR.

WANTED, an INSPECTOR, with thorough knowledge of Water Fittings. Wages 33s. per week

Applications, stating age and qualifications, with not more than three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Oxford, not later than Wednesday, the 15th of August instant.
Dated 1st August, 1917. 331

Wigston Magna Urban District COUNCIL.

WANTED, an ENGINEMAN (not eligible for Military Service) for Crow Mills Sewage Pumping Station. Must understand Gas Engines and Suction Gas Plants, and be able to execute small repairs.

Wages £2 5s. per week with 7s. 6d. War Bonus.
For particulars of duties and application form, apply to—
Mr. A. H. BURGESS,
Clerk of the Council.
2, Wycliffe-street,
Leicester. 316 A

Tyne Improvement Commission.
DREDGING SUPERINTENDENT.

The Tyne Improvement Commission REQUIRE the SERVICES of a competent person to discharge the duties of DREDGING SUPERINTENDENT. Salary £300 per annum.

Applications, stating age, present occupation, and past experience, and accompanied by three recent testimonials, to be sent to the undersigned, under cover marked "Dredging Superintendent," not later than noon, on Monday, the 6th August, 1917. The person appointed will be attached to the Engineer's Department, and his duties will include the superintendence of the whole of the Dredging carried out by the Commissioners in the River Tyne and the movements of the River Craft connected with the Dredging Work.

Further information as to the duties can be obtained on application.

Personal canvassing will be a disqualification.
By Order,
J. McDONALD MANSON,
General Manager and Secretary.
Tyne Improvement Commission Offices,
Newcastle-upon-Tyne,
25th July, 1917. 333

Wanted, a Good Practical Man as RATE FIXER in a large Crane Works, North of England. No person already employed upon Government work will be engaged. State experience and salary.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 304. 304 A

Wanted, a Manager for Cement Works; must be experienced and well qualified.—Address, stating salary required, P863, "The Engineer" Office. P863 A

Wanted, Engineer to Take CHARGE of Plant and Machinery. West Country. Experience with can-making and refrigerating plant preferred. —Write, stating experience and salary required, D., c.o., Wilts United Dairies, Ltd., Trowbridge. 320 A

Wanted, Foundry Manager for large Engineering Works in Midlands, thoroughly experienced green, dry sand and loam. State age, experience and salary required. No one on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3600. 330 A

Works Engineer, Over Military age, for a Manufacturing Concern in Lancashire (not engineering), employing about 900 hands. Duties consist of up-keep of all plant, machinery and buildings. Must have had similar experience, especially in building construction, as large extensions at present are taking place. No man at present employed on Government work will be engaged.—State age, full experience, together with salary required, accompanied by recent testimonials, to Box O278, Lee and Nightingale, Liverpool. 339 A

Works Manager. — A Really capable Man with sound Engineering Training and Experience in Works Administration is REQUIRED to take CHARGE of a large Aeroplane Factory; London, N.W. Applicants need not necessarily have had previous experience in Aeronautical Engineering. No one engaged on Government work, or resident more than ten miles away, need apply.—Write, stating salary required, to 322, "The Engineer" Office. 322 A

Assistant Engineer, Experienced in Blast-furnace and Steel Works Plant, WANTED for Steel Works in South Wales under Government control. Must be 6 o'clock a.m. man, ineligible for military service, and not already engaged on Government work.—Apply, stating age, qualifications, and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3439. 2/2 A

Buyer (Chief) Wanted by an important Company under Government control. Must have had wide experience in Engineering and General Buying, and be able to show good credentials.—Applicants should reply through nearest Employment Exchange, giving fullest particulars and stating salary required. No one at present on Government work will be engaged. Mention "The Engineer" and number 317. 317 A

Chief Engineer Required for large Aero Engine Works, London district; 2000 hands employed. Salary, £1000 p.a.—Address, stating experience to, 243, "The Engineer" Office. 243 A

Engineers with Practical Experi- ENCE of Design of Ferro-Concrete Structures REQUIRED by MOUCHEL and PARTNERS, Ltd., 36, Victoria-street, Westminster, S.W. 1.—Apply by letter, stating age, experience and salary required. P864 A

First-class Experienced Esti- MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Gas Engines and Suction Plant. —WANTED, ASSISTANT to Engineer-in-Charge. Must be competent to carry out Running Repairs. Good position to capable, trustworthy man.—Write, stating age, experience, and wages required, 188, "The Engineer" Office. 188 A

Night Superintendent Wanted, Machine Shop Experience, for Engineering Works (on Government work) employing 700 hands. No person residing more than ten miles away, or already employed on Government work, need apply.—Address, with full details, to 326, "The Engineer" Office. 326 A

Rate Fixer Required for Tool Room of Controlled Factory engaged on important Aero Engine work. Applicants must be thoroughly conversant with all kinds of machining and fitting required for Jigs, Tools and Gauges; Midland district. State age, experience and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 362. 362 A

Smart Man, with Good Machine Shop Experience, as ASSISTANT WORKS MANAGER in Engineering Works (on Government work) employing 700 hands. No person residing more than ten miles away, or already employed on Government work, need apply.—Address, with full details, to number 347, "The Engineer" Office. 327 A

Wanted, Competent Cost Clerk for large Government Controlled Engineering Works in Midlands, capable of taking charge. State previous experiences. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P874. P874 A

Experienced Wages Clerk, also TIMEKEEPERS, WANTED for Engineering Works.—Apply, stating age, experience, and wages required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3515. No person already on Government work will be engaged. 337 A

Cost Accountant Wanted in large Engineering Works in the Midlands employing over 5000 hands; an expert Cost Accountant. To a thoroughly capable Man, well versed in Accounts, and familiar with the latest Costing Methods, a permanent position is offered. Only those with practical experience in similar works need apply.—Address, stating age, experience, and present employment, which particulars will be regarded as confidential, 335, "The Engineer" Office. 335 A

Experienced Accountant Clerk WANTED, ineligible. One having had experience of Engineering Works preferred. Highest references essential. State age, experience, and salary required. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 368. 368 A

Secretary Wanted for Engineer- ING and Iron Foundry Works, one accustomed to Engineering Work and Costing, state age and previous experience, with salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 363. 363 A

A Large Machine Tool Firm REQUIRES REPRESENTATIVES for the following districts:—One for Scotland,
One for Tyne District,
One for South Wales, and
One for South of England.
—Address, stating salary, age, and experience, 352, "The Engineer" Office. 352 A

Wanted by Government Con- TROLLED Establishment in N.E. London district, several First-class DRAUGHTSMEN with Automobile experience. No applicant already employed upon Government work can be engaged.—Apply at your nearest Employment Exchange, quoting "The Engineer" and No. A3438. 193 A

Wanted Immediately, Draughts- MAN for General Engineering Works, East Midlands. Must have good knowledge of Machine Design. State fully experience, also age and salary required. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 260. 260 A

Wanted, Smart Draughtsman, by London Firm of Water-tube Boiler Makers. No person employed upon Government works, or resident more than ten miles from London, will be engaged.—Address, stating age and salary required, to 346, "The Engineer" Office. 346 A

Wanted, Thoroughly Good En- GINEERING DRAUGHTSMAN, preferably one with Aeroplane experience. Give full particulars and salary required. No one at present on Government work or resident more than 10 miles away need apply.—Address, 350, "The Engineer" Office. 350 A

Draughtsman, Junior, Mechan- ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234. 12 A

Draughtsman, Mechanical, One used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 A

Draughtsmen Wanted, Tho- ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 A

Jig and Tool Draughtsman Re- QUIRED by leading firm of Sheet Metal Workers in Birmingham area. Experience in the production of Aircraft Parts desirable. Permanent position for the right man. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3516. 361 A

Several Good Draughtsmen Re- QUIRED, also DETAILERS and LADY TRACERS for important War work in London district. Experienced in any of the following:—(1) Dredger work; (2) Steam power work; (3) General factory work. No person already engaged on Government work need apply.—Apply, stating full experience, when at liberty and wage required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3628. 359 A

A Large Engineering Company have a VACANCY for a first-class FOREMAN PACKER, who must possess an expert knowledge of the best methods of packing and protecting electrical machinery of all descriptions for foreign shipment. Good salary and permanent position to a suitable man. State age and experience. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3442. 205 A

Shop Foreman Required (7 o'clock man) to manage Sheet Metal Works, West London District. Must have had experience in cowlings, beaten work, tanks and aero. fittings. It is absolutely essential that applicant should be first-class mechanic, able to devise own tools and jigs for cheap production; thoroughly understand mechanical drawings and estimate from them. Previous experience as foreman an advantage, but not absolutely essential; a good mechanic possessing organising abilities, initiative and ambition will be considered. Good salary will be paid to the right man, with opportunities for advancement. Write, stating age, full particulars of previous experience and class of work engaged on, salary required, &c., to 315, "The Engineer" Office. No person resident more than 10 miles away or already employed on Government work will be engaged. 315 A

Wanted, Orders for

CONSTRUCTIONAL STEELWORK, TANKS, HOPPERS, ROOF TRUSSES, &c., HEAVY AND LIGHT PLATE WORK, by ENGINEERING FIRM in MIDLANDS.

Address, in first instance, P855, "The Engineer" Office. P855

Drivers Wanted for Turbo Gener- ATORS at a large Power Station in the Midlands. Certified Undertaking.—Apply, SMETHWICK POWER STATION, Downing-street. P861 A

Toolsetter for Capstan Lathes REQUIRED in North London Munition Factory. Anyone employed on Government work, or resident more than ten miles away, need not apply.—Address, 329, "The Engineer" Office. 329 A

Wanted, Position as Works MANAGER or HEAD FOREMAN or SUPERINTENDENT, by Practical Man (46), late Works Manager and Head Foreman Millwright.—Address, P867, "The Engineer" Office. P867 B

Works Manager (46) Shortly OPEN for ENGAGEMENT; twelve years' works management internal combustion engines; can handle male and female labour.—Address, P873, "The Engineer" Office. P873 B

Constructional Engineer and MANAGER, shortly to be disengaged, SEEKS APPOINTMENT; 10 years' experience on public works contracts; all branches of constructional works; used to dealing with large numbers of men and all kinds of contractor's machinery. Now employed constructing railways at one of H.M. munition factories (contract shortly terminating).—Address, 299, "The Engineer" Office. 299 B

Engineer-Buyer.—An Engineer, with long works' experience, is OPEN to INSPECT for PURCHASER, Test, Assemble and Dispatch Engineering Materials and Machinery for provincial or export house.—Address, 325, "The Engineer" Office. 325 B

Engineer, Extra First-class B.T. Certificate, WANTS POST as SUPERINTENDENT ENGINEER to Line of Steamships, or other Responsible Post.—Address, 366, "The Engineer" Office. 366 B

Engineer.—Manager, M.I.Mech. E., M.I.A.E., DESIRES CHANGE. Works or General Manager. Thoroughly experienced in General Engineering, War Material, Aero and Motor Trade. Accustomed to organising and handling large staffs. Very energetic, good disciplinarian and not afraid of hard work.—Address, P837, "The Engineer" Office. P837 B

Engineer (Now Abroad) Seeks MECHANICAL or RAILWAY APPOINTMENT; any part of world; four yrs. G.W.R., Swindon; marine and oil experience; five yrs. rubber, cotton, and tobacco in Tropics. Willing to proceed direct. Free December.—For particulars and testimonials, apply WALKEY, Canopus, Marazion, Cornwall. P794 B

Engineer Seeks Position of WORKS MANAGER, TECHNICAL MANAGER, or similar Responsible Position. Has held positions in equivalent capacities with leading firms.—Address, P866, "The Engineer" Office. P866 B

Russian Engineer (5 Languages), with high connections and references (now Artillery Inspector to the Russian Government in England), DESIRES POST as representative of British or American Firms in Russia.—Address, P835, "The Engineer" Office. P835 B

Swiss Engineer (32) Requires POSITION as DESIGNER or ASSISTANT WORKS MANAGER. General experience in Shop and Office (England and Continent); three languages.—W. F., 34, Alexandra-road, Finsbury Park, N. P869 B

Tyre and Disc Wheel Rolling. POSITION WANTED MILL MANAGER; would undertake Lay-out of New Plant and Extensions.—Address, P868, "The Engineer" Office. P868 B

University Trained Engineer (42), fully experienced in Superintending Works in England and Abroad, complete knowledge of Internal Combustion Steam, also Manufacture of Shells and Guns, experienced in Designs of Machinery and Tools, used to Managing Large Staff, DESIRES CHANGE. At present on important service.—Address, P865, "The Engineer" Office. P865 B

Working Drawings and Designs quickly and neatly prepared for general engineering work, by fully qualified engineers, A.M.I. Mech. E.—Address, P839, "The Engineer" Office. P839 B

Young Engineer Requires Posi- TION as ASSISTANT MANAGER; good draughtsman, four years D.O., eight years shop; sound knowledge of filling and manufacture of fuses, grenades, bombs, &c., good experience on jigs and tools.—Address, P870, "The Engineer" Office. P870 B

Chemist Desires Change; Able to take charge of Laboratory; 14 years' good general experience in analytical, metallurgical, and assay work; highest testimonials.—Write, P872, "The Engineer" Office. P872 B

Metallurgical Chemist (Re- JECTED), having thorough technical training and wide experience of manufacture, analysis, physical and mechanical testing of Iron and Steel, and conversant with modern methods, DESIRES responsible progressive POSITION on these lines. Could assist manager. Details and ref. on application. Commencing sal. reqd., £300 min.—Address, P871, "The Engineer" Office. P871 B

To Aeroplane and Munitions Manufacturers.—DRAUGHTSMAN offers his SERVICES on completion of erection of large national factory. Well versed in planning and building requirements for aero and munitions plant. Quantities, handling of men, speedy erection, supervision and accounts.—Address, 2/5, "The Engineer" Office. 275 B

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Wanted.—The Pioneer Electric CO., 22, Churchgate-street, Fort, Bombay (India), DESIRES CONNECTION with DEALERS in SECOND-HAND MACHINERIES—Electric, Boilers, Oil, Steam or Gas Engines, &c. P791 p

London Representation.—Advertisers have had 15 years' experience in Railway Rolling Stock Supplies and Plant for Colonial and Foreign Railways. Acquainted with the leading consulting engineers' requirements. AGENCIES for Specialities of particular interest to railways and the export trade generally WANTED either immediately or later on.—Address in confidence, 7, "The Engineer" Office. 7 p

Directorship Required by an Experienced Civil Engineer having capital and extensive commercial connections. Give full particulars, stating capital required for investment, and amount of fees per annum.—Address, 297, "The Engineer" Office. 297 c

Wanted, Belt Conveyor, About 18in. wide, 70ft. long; can supply M.M. Certificate, Class B.—Address, 323, "The Engineer" Office. 323 r

Wanted, Generating Set, About 80 B.H.P., comprising Gas Engine, direct-coupled to compound-wound 6-pole generator, suitable for 220-250 volts, D.C.; gas engine to be driven off town gas. Must be in first-class condition and by approved makers.—Send full particulars to 185, "The Engineer" Office. 185 r

Wanted, Generator, 115-120 volts, 450-550 ampères; also MOTOR, 110 volts, 25-30 H.P. Must be in good condition.—JARDINE, Nottingham. 338 r

Wanted, Immediately, 500-600 K.W., D.C., 220 volts GENERATING SET; Diesel Engine preferred; either direct-coupled or rope-driven.—Full particulars and price to MARSHALL, SONS, and COMPANY, Ltd., Gainsborough. 313 r

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.R., Smith's Agency, Ltd., 109, Fleet-street, E.C 1 r

Hydraulic Press Wanted, Suitable for flanging steel barrel ends up to 24in. or 30in. dia., and 5-32in. thick.—Full particulars with illustration and price to MOCKRIDGE, 17, Second-avenue, Plaistow, E. 13. 367 r

Locomotives Wanted. — Two Six-wheeled SHUNTING LOCOMOTIVES, standard gauge; must be in first-class condition, ready for immediate work.—WORKS ENGINEER, The Austin Motor Co., Ltd., Northfield, Birmingham. 365 r

Required, 5-Cwt Steam HAMMER, in first-class condition.—Full particulars and illustration if possible, to 310, "The Engineer" Office. 310 r

A New Crossley 25 H.P. Gas ENGINE. Never been erected. FOR immediate SALE.—COLLINS, Keen's-road, Croydon. 328 c

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London, S.E. Telephone No. 978 Hop. 822 c

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For Sale:—

One 600 K.W. GENERATING SET, Engines by Bellis and Morcom, Ld.; cyls. 16½ and 23in. × 42in. stroke. "Parker" Generator, 520 volts D.C. Complete with surface condenser, motor-driven Pumps, &c.

One 125 K.W. Ditto ALTERNATOR by Ferranti, Ltd., 2000 volts, 50 periods. Vertical Cross Compound Engine, 250 H.P., by J. and H. McLaren.

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MORTAR MILL, under driven, 6ft. dia. pan, engine 7in. × 12in.

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Large Quantity YORKSHIRE and other GAS COKE.

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Two LANCASHIRE BOILERS, each 28ft. × 7ft. for 180 lb. working pressure, complete with Hopkinson stokers. Quick delivery.

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For Sale, Motor Generator, by G.E.C., 500 volts, 225 amps., 650 r.p.m., shunt wound, with two Boosters, series wound, 110 volts, 400 amps., six-pole machines. Seen fixed. Immediate delivery.—WILLIAMS and SONS, South Bermondsey Rly. Station, London, S.E. 16. 354 o

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For Sale, One New 30-Brake H.P. Marshall GAS ENGINE with Suction Producer Plant (no cooling tanks or piping). Price and particulars from MARSHALL, SONS and CO., Ltd., Engineers, Gainsborough. 148 o

For Sale, One 140 B.H.P. Horizontal Hornsby-Stockport GAS ENGINE, with magneto ignition, heavy fly-wheel, complete with Suction Plant of two Generators and cleaning apparatus. Immediate delivery. In first-class condition.—Address, 366, "The Engineer" Office. 366 o

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90 K.W. Steam Generating Set; high-speed enclosed engine, coupled to multipolar generator, 500 volts D.C. For immediate delivery.—HARRY H. GARDAM and CO., Ltd., Staines. 1343

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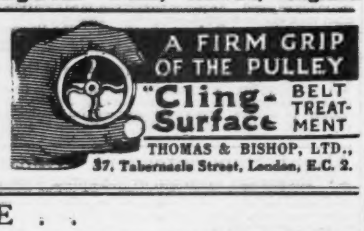

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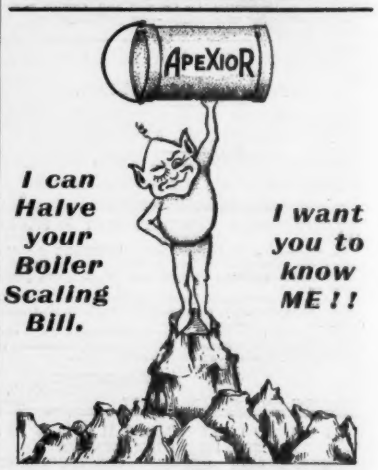

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JULY.

'Prentices.

A Council meeting of the North-East Coast Institution in November last adopted a memorandum on the Education of Apprentices submitted by the secretary, and resolved to develop a scheme for putting the principles enunciated into practice. For this purpose a committee was appointed. It began its sittings almost at once, and having considered the matter from all points of view presented its report to the Council on June 4th. The report was adopted and was then submitted to the following employers' associations: the North-East Coast Engineering Trades Employers, the North-East Coast Ship-repairers, the Tees and Hartlepool Shipbuilders, the Tyne Shipbuilders, and the Wear Shipbuilders. These five associations have expressed their full sympathy with the objects arrived at in the report, and with the exception of the last, which desires to give further consideration to some points, they approve the scheme and have agreed that the North-East Coast Institution shall act as their representative in a consultative capacity with the local education authorities for the development of apprentices' training in technical education. The scheme thus having been accepted by the general body of employers on the North-East Coast was printed and circulated a few days ago. As the main points were given in our last issue, we need not attempt to summarise them here, but we may recall that the report lays strong emphasis on the need of better technical education of young mechanics and proposes an arrangement whereby those youths who show most indication of talent and industry would be selected at different stages for promotion to work of a higher class. Beginning their apprenticeship between fifteen and sixteen, the bulk of the lads would give two to three half-days a week to continuation classes, whilst the selected minority would spend half their time in the works and half in a technical college. At eighteen years of age the bulk would continue as ordinary 'prentices, taking evening classes if they liked, whilst part of the better youths, the "special quality" as they are called, would take the full university course of applied science. We gather that part of the expense of this reformed education will fall upon the employers, but that the Board of Education is to be asked to give greater financial aid to technical classes on the North-East Coast, and to undertake their reform in the terms of this report.

The Coal Transport Reorganisation Scheme.

At the present time there is considerable expenditure of energy, not only in conveying coal from distant areas, but in very many cases in sending it from one coalfield to another. Coal, for instance, is to-day being conveyed from South Wales to the south-western counties of Scotland, to Durham and to Yorkshire, whilst it is sent from the Yorkshire and North Staffordshire coalfields to South Wales. Altogether there are three hundred and twenty-two exchanges between coal-producing and coal-consuming areas—the whole of England, Wales and Scotland being regarded as containing twenty areas—independent of the coal consumed in the area wherein it is produced. The conveyance of this traffic means an occupation of the railway lines, the use of much locomotive power both for transit and for shunting, and the use of wagons. With a view to preventing this waste Mr. Guy Calthrop, the Controller of Coal Mines, has, with the assistance of the Railway Clearing House, had a census prepared of the "coal" journeys—many of them of great length, extending, for instance, from South Wales to the north-eastern counties of Scotland—and he has set to work to devise a scheme under which each consumer must obtain his supply within or near his own area. The main features of this scheme were announced on July 7th. Under it the number of exchanges between the twenty areas will be brought down to seventy-eight, a reduction of 75.77 per cent., and it is estimated that there will be a saving of 700 million ton-miles. The scheme is to come into operation on Monday, September 10th, and on the previous Saturday all existing contracts wherein the supply does not conform to the new regulations will automatically terminate. The District Coal and Coke Supplies Committees, already in existence, are to put producers and consumers in touch with each other so that by the dates just mentioned the supplier will have been furnished with new customers to replace those he will lose, and the consumer will have been told who will, in future, furnish him with the coal he requires. There will have to be no little give-and-take, but the matter is in the capable hands of men who are well acquainted with the production and consumption of coal. The new scheme does not apply to water-borne coal—either export, coastwise, or bunkers—anthracite, or coke of any description. Nor, as already indicated, will contracts for coal, produced and consumed within the same area, be disturbed.

Welsh Railways.

In the year 1909 two Bills were before Parliament; one for vesting the Cardiff Railway and the Bute Docks in the Taff Vale Railway Company, and the other for vesting the Rhymney in the Taff Vale. Both were passed by the House of Lords, but after six weeks' hearing the Cardiff and Bute Docks Bill was rejected and the Rhymney scheme was then withdrawn. Of late there have been signs of a revival of these proposals, and the first public intimation of a closer working arrangement between the companies came at the end of March, when it was announced that Mr. C. S. Dennis, the general manager of the Cardiff, had retired, and that Mr. E. A. Prosser, the manager of the Rhymney, would be the general manager of both systems. On Friday, July 6th, there was a meeting in London of representatives of the boards of the Taff Vale, Rhymney, and Cardiff Companies, after which it was publicly announced that Mr. A. Beasley, the general manager of the Taff Vale, was retiring and that he, too, would be succeeded by Mr. Prosser. In this official intimation it was announced that Mr. Prosser was already the general manager of the Cardiff and Rhymney Companies, so that the appointment then made constituted him the general manager of the three companies, and it was hoped thereby to produce centralisation of management and working for the improvement of facilities, both at the important Bute Docks and the railways serving these docks. It was believed that the movement would have the most beneficial effect, not only upon the interests of the companies concerned and the traders of the district, but also upon the future and development of the city of Cardiff. Mr. Beasley has since been appointed a director and vice-chairman of the Taff Vale. The new scheme, we would add, will be of great benefit to the Cardiff Railway. If the map of that system given on page 409 of The Engineer of October 14th, 1910, be referred to, it will be seen that the Cardiff Company has no direct access to Cardiff, but has to run over the lines of the Rhymney Company, and that, in 1902 and again in 1903, it was proposed to put in a junction between the Taff Vale and the Cardiff Railways which would have been a public convenience and a source of profit to the Cardiff, but the Taff Vale successfully opposed the proposals. No real fusion can, of course, be made without the consent of Parliament.

Shunting Movements on Railways.

The vehicles forming the shuttle service between Dalmeny and Ratho on the North British Railway have, for over twenty years, been reversed, *i.e.*, the engine transferred to the other end of the train, at Queensferry Junction on the Edinburgh and Glasgow main line, by methods that were irregular and dangerous. But because they were daily made by men who knew what to do, the methods, although irregular, did not develop into being dangerous. However, with the opening of the present year, and the large withdrawal of trains, a driver who was unacquainted with the peculiarities of the situation and who did not appreciate the dangers, had to perform the operation. For the first two days all went well, but on the third day the signalman apparently assumed that the driver "knew the ropes" and so he failed definitely to instruct the latter what to do and what not to do. The driver, equally ready to jump at conclusions, assumed that because he had not been told to stand still he might move, went ahead and caused the serious Ratho accident, in which twelve passengers were killed, on which Colonel Pringle's report appeared on July 11th. This report was noteworthy for two points to which the Board of Trade inspector referred. The first arose out of the fact that the district traffic inspector for the area in which the accident occurred used to be a signalman at that very box, and Colonel Pringle pointed out that men so promoted are not likely to appreciate, as inspectors, the irregularities and dangers of systems which they have had to work as signalmen. The other point is that this was another case of an accident caused through a light engine, and he recommended that competent officers should make periodic inspections of, and investigations of the methods employed at, junctions and other centres where passenger and goods trains terminate, to see that the disposal of the vehicles is conducted with the proper and efficient equipment of signals, trap points, and other safeguards.

Education or Commerce and Industry.

Only editors in search of copy and a few municipal councillors read the weekly reports that are issued by the London County Council. Speaking generally, that is a natural attitude. In an ideal community every citizen would take a keen and active interest in the communal management of his affairs, but human nature is not strong enough, nor ever will be sufficiently dutiful and sufficiently robust for a regimen of municipal reports. Now and then, however, a report breaks loose from the general ruck and affords reading of a human kind. It leaves financial intricacies and touches subjects that come nearer to us all. Of such subjects are the boys and youths, and nowadays the girls, who are engaged in our offices. Not even the most fortunate of us would assert that all is right with these classes of the population, and all of us will agree that the London County Council did well when it resolved to find out, through its Education Department, what was wrong. The Department sent out a whole lot of enquiries and received a host of criticisms from employers in commerce and industry. From the replies it is made evident that there is something wrong with the education of our young people, and we learn with great satisfaction that the Council proposes "to enlist the co-operation of prominent business men and men of affairs to bridge the gulf which separates education from commerce and industry," and that it has already appointed advisory consultative committees of business men for "banking, chemistry, dress and the allied trades, and engineering." Everything that brings education into closer touch with the requirements of the industries of the country makes for increased efficiency and helps to remove the complaint, all too common in business circles, that the educationalist is turning out a product which is of little real value to the country until it has been wholly reformed. We suggest to all who take an interest in the problems of utilitarian education that they should obtain and read the pages devoted to this subject in the last report of the London County Council. We may add that the Committee for Engineering is composed of Mr. E. Bruce Ball, Dr. Dugald Clerk, Sir John Snell, Mr. Wilfrid Stokes, Sir Vincent Raven, Mr. C. P. Sparks, and Sir Charles Parsons. This list of names will serve to indicate that real engineers are taking an interest in the movement.

Charges for London Water.

The question of the charges for water in the metropolis came rather prominently forward during the month. It is a wonder to us that it has not done so long before this. Under the old companies the charges varied in different parts of the area supplied. The variation was, roughly, from about 3½ per cent. to 7 per cent. on the rateable value. When the Metropolitan Water Board was constituted it was enacted that after a certain period the amount charged should be a flat rate of 5 per cent. on the rateable value over the whole area. There were also special arrangements for water supplied for certain purposes. Before the Act had received sanction it became evident that, owing to clauses inserted during the passage of the Bill through Parliament, there would certainly be a deficit in working as soon as the time came to charge the flat rate of 5 per cent. This deficit was, as a fact, experienced, and instead of growing less it has grown more as time has gone on. The matter has received the attention of the Board itself during the past few weeks, but the decision has been come to that nothing can be done without Parliamentary powers, and that the present is not the time to seek such powers. In order to make up the deficiency hitherto experienced, precepts have been levied on the various authorities represented on the Board, and these authorities have collected the money from the ratepayers, embodying the amount in the usual demand for rates. Because the call has been made in this way, and not separately, and because the amount, hitherto demanded at a time, has been comparatively trifling, the matter has doubtless escaped the notice of the ratepayers, though we have on several occasions drawn attention to it. Recently, however, there have been evidences that the authorities and ratepayers are at last waking up to the fact that they are in reality paying two water rates. A quite influential meeting of representatives of various local authorities discussed the matter. It is no wonder that annoyance is felt regarding it; but the whole of the present position might have been foretold, and it was, indeed, prophesied in these columns.

If the control of the affairs of a big undertaking be taken out of the hands of commercial people and put under the control of, say a Board, it can easily happen that profits vanish and a loss be met with. After all, the blame largely rests with those who clamoured so loudly for the abolition of the companies; and yet in what are they any better off? It is true that by the institution of the flat rate some districts even with the additional rates are paying less than they were before; but as against that some districts—the City for example—are paying a great deal more. Well might, to the general profit, have been left alone.

Naval Events.

The war at sea during the past month has pursued its average course, the incidents reported all being of a minor nature. The British Navy has, however, suffered some regrettable losses in the course of fulfilling its routine duties. On the 4th it was announced that one of his Majesty's destroyers of an old type had been mined in the North Sea and had sunk. Eighteen of her crew were rescued. On the same date a British mine-sweeper struck a mine in the Mediterranean and sank with the loss of ten of her crew. On the 6th a British destroyer was torpedoed and sunk by an enemy submarine in the North Sea. Eight of her crew were lost. On the night of the 9th, H.M.S. Vanguard, while at anchor, was blown up as the result of an internal explosion. The vessel sank immediately, and of those on board but two are alive to-day. Ninety-five of the ship's company were not on board at the time of the disaster. A full inquiry has been ordered. The battleship Vanguard was completed at Barrow in 1910, and had a displacement of over 19,000 tons. Her main armament consisted of ten 12in. guns. She carried a normal complement of 724 officers and men. On the 16th some British light forces on patrol in the North Sea sighted a number of German steamers. Disregarding signals to stop and warning shots fired across their bows the enemy vessels made off towards the Dutch coast. Two of them reached the shore badly damaged by the gun-fire of the British ships. The remaining four, however, were intercepted and brought into port as prizes. The German steamers, it is understood, were on a voyage from Rotterdam to Emden with coal and provisions. On the 22nd the armed mercantile cruiser Otway was torpedoed and sunk in northern waters with the loss of ten men killed. This vessel of 12,000 tons gross was built at Fairfield in 1909, and belonged to the Orient Steam Navigation Company. On the same date it was reported from Berlin that the British submarine C 34 had been sunk by an enemy submarine. Only one of the crew was saved. On the 27th a British submarine on patrol in the North Sea overhauled and captured the German steamer Batavier II. A prize crew was placed on board, but owing to the damage caused by our gun-fire, it was found impossible to bring the vessel into port. She was accordingly sunk. On the 30th, the Admiralty announced that the British cruiser Ariadne had been torpedoed and sunk with the loss of thirty-eight lives. This vessel, of 11,000 tons, was launched in 1898, and before the war was regarded as practically obsolete.

Aeronautical Activity.

Intense aerial activity has characterised the past month as it did its immediate forerunners. During the night of the 2nd and the morning of the 3rd Naval Air Service machines dropped several tons of bombs with good results on the docks at Bruges and on ammunition depôts at Lichtervelde. All machines taking part in this raid returned safely. Soon after 7 a.m. on the 4th some twelve or 14 enemy aeroplanes attacked Harwich. Low-lying clouds rendered visibility bad, but nevertheless the enemy's formation was broken up by our anti-aircraft defences and aircraft from a neighbouring station. Little material damage was done, but eight people were killed and twenty-two injured. The raiders speedily departed and were intercepted by the Dunkirk squadron on their way home. As a result of the engagement which followed two of the enemy machines were driven down in flames, while a third was seen to be badly damaged. All our machines returned safely. On the night of the 3rd–4th Naval machines carried out a bombing attack on the aerodromes at Ghistelles and Nieumunster, on the seaplane sheds at Ostend, and on a train at Zarren. All the machines returned safely from this raid. Ghistelles aerodrome was again bombed on the evening of the 7th. The British machines were heavily attacked by a hostile formation, but all succeeded in returning safely. At about 9.30 a.m. on the 7th hostile aeroplanes in considerable numbers appeared over the Isle of Thanet and the east coast of Essex. Dropping some bombs in Thanet the raiders, or some portion of them, followed the course of the Thames to London, which they crossed from north-west to south-east and bombed freely. The enemy machines were hotly received by our gunners and aeroplanes. One was brought down by a military pilot off the mouth of the Thames. Naval machines from this country chased the raiders on their way home and engaged them forty miles out to sea off the East Coast. Two of the enemy were seen to crash into the sea and a third was driven down in flames off the mouth of the Scheldt. All our machines taking part in this engagement returned safely. Meanwhile, on word being received that hostile aircraft were attacking England five flights of naval aeroplanes rose from Dunkirk to intercept them. The raiders, however, were not seen and are believed to have returned to their base over Dutch territory. In the course of their patrol the British naval machines encountered three enemy seaplanes and destroyed them. In addition an enemy aeroplane was driven down into the sea, a second one was shot down in flames, a third was driven down out of control, and a fourth was compelled to land damaged on the beach near Ostend. As a direct result of the raid on London, therefore, the enemy definitely lost nine machines on this day. The number of machines which actually took part in the raid was probably about twenty. The damage caused was not excessive. The casualties so far announced amounted to fifty-nine people killed, and one hundred and ninety-three injured.

Further Aeronautical Activity.

During the night of the 6th–7th an extensive series of reprisal raids was carried out by eighty-four French machines against points in German territory or in German occupation. Some 13 tons of bombs were dropped. The chief points attacked were Trèves, Ludwigshafen, Essen, Coblentz, Hirson, Phalsburg, and Thionville. Two of the French machines failed to return. On the 9th the British armed trawler Iceland destroyed two enemy seaplanes in the North Sea off the East Coast. It is understood that these seaplanes were making an attempt to attack some shipping with torpedoes. On the same date an air raid by British naval machines was carried out against the Turco-German fleet lying off Constantinople. From a height of only 800ft., the Goeben and other enemy war vessels received direct hits, big explosions and several fires being observed on board them. A direct hit was also obtained on the Turkish War-office. On the 11th a flight of five naval machines on patrol to the south-west of Nieuport met and engaged ten Albatross scouts accompanying three large two-seater machines. Three of the enemy scouts were driven down completely out of control, and two others were driven down. One of our machines failed to return. During the night of the 11th–12th a series of bombing raids was carried out by Naval Air Service machines against several military objectives in Belgium. The points attacked were a railway dump at Varssenaere, where an intense conflagration was caused, St. Denis-Westrem, Ghistelles, and Ostend. The railway siding at Zarren was attacked by gunfire from the air. None of our machines failed to return. On the following night the same service bombed the enemy aerodromes at Aertrycke, Houttave-Nieumunster, and Ghistelles, railway junctions at Thourout and Ostend, Bruges Dock, and the Mole at Zeebrugge. Zeebrugge, Ostend, Middelkerke, Thourout and Lichtervelde received attention on the night of the 15th–16th. On the morning of Sunday, the 22nd, some fifteen to twenty-one enemy aeroplanes dropped bombs in the Felixstowe and Harwich area. Little damage was caused to property, but eleven people were killed and twenty-six injured. In spite of poor visibility the enemy was hotly received by gunfire, and was encountered by a patrol of the Royal Flying Corps, which succeeded in bringing down into the sea one of the raiders. During the night of the 28th several tons of bombs were dropped by naval airmen on works at Bruges, and in the areas of Thourout, Middelkerke, and Ghistelles. All our machines, as in the previous raids reported during the month, returned safely. The aerial activity on the British western front during the month has been on an intense scale, and has been characterised by the large formations on both sides taking part in common engagements. The Germans seem to have put up a very stiff fight for supremacy in the air, but that they have failed to acquire it seems undoubted. Up to and including the 29th the enemy's losses during the month as reported by Sir Douglas Haig amounted to one hundred and sixteen machines destroyed in air fighting, one hundred and twenty driven down out of control, six shot down by gunfire, and four observation balloons set on fire. During the same period eighty-eight British machines were reported missing.

The London County Council Tramways.

The accounts of the London County Council Tramways for the year ended March 31st last, which were published during the month, are slightly more favourable than for several years past. Instead of an estimated deficit of some £74,000 there was, in fact, a sum of £11,342 odd to carry to the Reserve Fund, to which nothing derived from the actual working of the tramways had been added since the year 1912–13, when £497 were paid in. As indicating, however, that, though they show improvement, things are by no means what they should be, we may say that even at the Council's low rate of two-thirds of a penny per car mile a sum of over £137,000 should have been put aside for renewals, and that the estimated expenditure on renewals during the current year is to be over £88,000. The net result will be that if everything goes on as the Highways Committee thinks it will, the Renewals Fund, which stood at £282,978 on the 31st March last, —or rather, at something considerably less than that amount, since no account was taken of the depreciation of investments—will by the 31st March next have been reduced to an estimated amount of £200,112—no account again being taken of the depreciation of investments. There is, however, a somewhat brighter side of the matter to which it is really a pleasure to refer. The receipts of the undertaking are certainly on the upward grade, and this, notwithstanding a decrease in the number of passengers carried. For the period of the year from April 1st up to the week ended the 18th July there was an increase in the traffic receipts of £106,663, as compared with the corresponding period of last year, notwithstanding the fact that 664,528 fewer passengers had been carried. In other words, though there were nearly 6 per cent. fewer passengers, there was an increase in receipts of nearly 13½ per cent. in the takings. How much of this is due to the abolition of halfpenny fares and return tickets—which was effected at the end of May last—and how much to other causes, we have no information to enable us to decide. We think it quite possible, however, that to the first-named cause is due a good deal of the improvement. We have always maintained that some of the fares charged were ridiculously low.

Foreign Trade.

It will be recalled that a good many months ago the Federation of British Industries circulated a series of "Recommendations for the Development of the Government Service for the Promotion of British Trade in Foreign Countries." Those recommendations were placed before the Government at the same time as others from the Chambers of Commerce, which differed but little from them. The Government appointed a Committee to consider both documents, and the Committee made a majority and a minority report some time ago. There the matter has stuck ever since. The reports of the Committee have not been published, and no one outside the Government knows their tenour, though it is believed that the recommendations were favoured by the majority. A feeling of uneasiness is created by this suspense, and we are not surprised that the Federation has within the last few days re-stated its principles in a brief form. They are (*a*) that all activities undertaken by the Government for the promotion of British trade in foreign countries must be concentrated under the control of a single responsible department; (*b*) that foreign commercial policy can only be successfully conducted as an integral and most important part of foreign policy, and that consequently the controlling department can only be the department in general charge of foreign affairs; (*c*) that for this purpose a well-organised commercial branch must be added to the existing Foreign-office, working in the closest possible co-operation with the political branch; and (*d*) that men serving in this branch and serving in the various posts abroad must receive position and pay of a sufficiently high level to ensure the best possible talent being attracted to the service in sufficient quantity.

Mid-Scotland Canal.

The air has been cleared as to Government intentions on this question, by a statement which has been issued by the Lords Commissioners of the Admiralty. Reference was made in the review for

June, to the steps which were being taken by the various authorities interested, to bring their views on the subject of the proposed Forth and Clyde Canal before the Government. There was at that time a widespread belief in business circles and among the officials of the corporations concerned in any such project, that the Admiralty was favourably disposed to consider plans which had, it was stated, been prepared for a ship canal by the Loch Long-Loch Lomond route, which would carry the canal through districts commercially undeveloped. Under these circumstances the Mid-Scotland Canal Association, in conjunction with the Convention of Scottish Burghs and the Corporations of Edinburgh and Glasgow, made representations in favour of a route for the canal between Grangemouth and Glasgow, which would serve the transport needs of important industries without in any way impairing the utility of the canal from the Admiralty standpoint. It is recognised that there is no justification for the construction of a ship canal between the east and west coasts of Scotland, to link up the Firth and Clyde navigations on purely commercial grounds; but should naval needs require the construction of the canal, there is no reason why industrial as well as strategical purposes should not be served. It is satisfactory to learn, therefore, that the Admiralty is not committed to any particular scheme or route, and an assurance has been given to the Joint Committee by the Lords Commissioners, that should a decision favourable to the construction of a Forth and Clyde Canal be reached, all the different interests concerned will be granted the opportunity to state their views as to the route to be followed, as well as on other matters. This intimation has not been accompanied by any categorical denial of the rumours regarding plans and official preference for the Loch Lomond route, and, although for the moment, fears that these may be adopted have been allayed, the campaign of publicity in favour of the direct route will be continued.

Irish Peat Committee.

THERE have been frequent attempts spread over many years to bring about the commercial utilisation of Irish peat deposits, and although there are technical as well as financial difficulties to be overcome, there appears to be no adequate reason why success should have so long eluded those who have worked at this subject. Hope that a practical plan for making use of these important deposits on national lines may now be made available, has been revived by the action of the Department of Scientific and Industrial Research, which has appointed a committee, of which Sir John Griffith is chairman, and for which it is understood the co-operation on the technical side has been secured of the Institution of Civil Engineers of Ireland, the Engineering and Scientific Association of Ireland, and the Institution of Electrical Engineers (Ireland). The fact that practically the whole of the coal used in Ireland has to be imported emphasises the need for evolving a commercial method for the general utilisation of peat as fuel. In the past, various methods of drying and compressing the peat have been the subject of experiment, as it is clear that owing to the low calorific value of the treated material and its bulk, transport charges must be reduced to a minimum. Modern opinion favours the use of peat fuel in electric supply stations erected in the vicinity of the peat deposits rather than its direct utilisation by individual consumers, which is the practice at the present time. The employment of peat fuel in producer plants opens up a somewhat promising field, particularly when its use is associated with the generation of electrical energy and the recovery of by-products. These and many other questions will receive the consideration of the expert committee which has been appointed. It would mean much to Ireland if the extensive beds of peat, estimated to extend over an area of $2\frac{3}{4}$ million acres, could be pressed into industrial service, and there will be a general desire that success may attend the work of the committee.

Charing Cross Bridge.

THE Bill for the strengthening of Charing Cross Railway bridge, which was thrown out last session, has now been approved, and an early beginning will be made with this very necessary work. It will be recalled that the plans which have now been sanctioned involve the expenditure of the comparatively small sum of £167,000, this modest outlay replacing a proposed expenditure of £750,000 on a bridge-widening scheme, for which the South-Eastern Railway first obtained powers in the year 1900. The carrying out of the widening was deferred for various reasons, partly financial, but also connected with the agitation for the removal of the railway terminus to the south side of the river Thames. As nothing definite has ever resulted from negotiations with the London County Council on this subject, and as more onerous traffic conditions were gradually limiting the use of the older portion of the existing structure, it became necessary to take definite steps in the matter, and the present scheme was the outcome. In railway and engineering circles the urgency of the need has been generally recognised for some time past, but Parliamentary assent was only obtained when the railway company agreed not to begin the construction of works above water level until the expiration of three years from the passing of the Act, unless the Board of Trade should decide that it was in the public interest that this condition should be waived. The existing bridge includes a six-span structure carrying four tracks, which was opened for traffic in 1864, and an addition made in the eighties, carrying three tracks. The older portion of the bridge has obvious defects, judged by the modern standard. The supporting columns are not only of somewhat small diameter, but too few in number for modern locomotive and train loads, and criticism has also been directed at the design of the cross girders as well as of the use of pin joints for the main girders. In view of the present comparatively low and diminishing factor of safety, only two of the four tracks of the old bridge, and these not adjoining tracks, can be used simultaneously, a serious traffic restriction resulting. Under the scheme now approved the cross girders will be supported at two intermediate points by balanced cantilevers, which will be carried on masonry piers, which it is proposed to construct between the old bridge piers. This course will not only enable the best use to be made of the structure at moderate cost, but will also tend to improve the appearance of an admittedly ugly bridge, as may be judged from the view of the proposed reconstruction given in our issue of June 30th, 1916.

Industrial Unrest.

IN but little more than a month after its appointment, the Commission on Industrial Unrest was able to send in the reports from its eight sections. On July 17th Mr. George Barnes had completed a summary of all the reports and sent it to the Prime Minister, and a few days later it was available to the public. On Monday last the first of the complete reports, appropriately enough that for Wales, was published. From all this it will be seen that Mr. Lloyd George's promise that the whole question should be looked into with the greatest expedition was amply fulfilled. Indeed, had we not the Welsh report before us, it would be natural to conclude that work done so quickly could not be well done, and that recommendations had been drawn up too hurriedly to be trustworthy. In these recommendations—we refer to those summarised by Mr. Barnes from all districts—the first place is given to food prices, which all the Commissioners hold should be reduced at once. Profiteering is regarded by the Commissioners as one of the chief causes of the present unrest, and it is satisfactory to know that this cause, at least, is likely to be removed under Lord Rhondda's scheme, at an early date. The second recommendation expresses approval of the Whitley report on Industrial Councils, the third invites the Government to make an authoritative statement about further increase of output, and the fourth advocates co-partnership of some kind. Amongst the remaining half score may be noted numbers nine and ten, of which the former calls for the payment of a bonus to skilled supervisors, and the latter asks for the establishment of closer contact between employer and employed. It is a comfort to know that, in the view of the Commissioners, "Feelings of a revolutionary character are not entertained by the bulk of the men," but that on the contrary, the bulk of them "are sensible of the national difficulties." The remaining seven reports appeared close on the heels of the first.

PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT.

By GEORGE KENWORTHY, Asso. M. Inst. C.E.

No. IV.* (*concluded.*)

SECTION III.

OVERSIGHTS DURING MANUFACTURE.

TEMPLATE VARIATIONS.

THE first process of manufacture is templating, the work being set out on the floor, and templates for marking being prepared therefrom. In some instances, where there is little repetition, the material itself is marked direct, but generally wood or steel strips are made for marking sections, and wood frames or metal sheets for large plates.

There is a factor which is not generally as carefully observed as it should be, which is frequently the cause of bad work in the first place, and eventually serious initial stress in the finished structure. This is the alteration from time to time in wood templates due to wet or dry weather, and in steel strips due to changes of temperature, although the setting out may have been done quite accurately, and the making and machine work on the material carefully carried out. It is remarkable that wood of fair quality and reasonable seasoning, even though only the common spruce, will vary very little in length owing to wet or dry, cold or hot weather. In fact, the variation in length is so little that it may generally be ignored; but a 6in. wide strip of the same wood will vary in width as much as $\frac{1}{4}$in., owing to the weather being dry or wet.

Pitch pine is the best template wood for strips, and the manufactured wood known as "three-ply" for plate templates, though the former is too expensive for general use. Yellow pine, as used for pattern-making, though rather soft, is quite a good substitute for pitch pine, whilst white pine or even spruce, the commonest of all, is suitable enough for ordinary work. It is obvious that wood templates should not be made too long a period before using, and that the templates for any one job should be made as far as possible under the same weather conditions, *i.e.*, once started, they should be pushed rapidly through at that one time.

A very important point is the position of the holes in any frame template. Fig. 22A shows a frame template for the 9in. flange plates of a girder, the holes being 5in. across centres. It will be noticed that the strips are made to come to the edges of the flange, thereby throwing the holes off centre in the strip. Fig. 22B shows how this template should actually be made, the centre of the strips

Fig 22

being arranged so as to be the same as the centre of holes, small strips being placed at intervals to maintain the full width of the flange. It will be seen that any variation in the width of the strips seriously affects the cross centres of holes in Fig. 22A, but in Fig. 22B, as the variation takes place each way from the centre of each strip, the 5in. cross centres is always the same. This consideration is very often overlooked, although it is of first-rate importance to good work, and, as is shown later, alteration of templates during manufacture is eventually the cause of initial stress in the riveted parts.

Now, a steel bar will elongate as much as $\frac{1}{4}$in. in 40ft. if the temperature rises from, say, 25 deg. Fah. to 75 deg. Fah.—a change of temperature quite possible between winter and summer. Assume that the main angles and webs of a large number of girders—which are running through the shops over a considerable period—are marked and drilled off a wood template strip in February, but that some of the flanges are not drilled till June, though they are marked off the same wood template. It is quite conceivable that when the work is put together the main angles and web will have elongated until they are $\frac{1}{4}$in. longer than the flanges which attach to them.

When the girder is being built up tackle will be brought to play which will tend to shorten the former and lengthen the latter. If the area of the one is to the area of the other as 4 is to 3, then

$$\frac{\text{Compression in angles and web}}{\text{Tension in flanges}} = \frac{3}{4}.$$

But though the total difference in length = $\frac{1}{4}$, yet, allowing $^1/_{16}$in. for play in holes,

Effective alteration in length in 40ft. = $^3/_{16}$in.

$$\text{Stress} = E \times \text{strain} = {}^3/_{16}\text{in.} \times 13{,}400 \times \frac{1}{480} =$$

5.2 tons per square inch.

* No. III. appeared July 20th.

Compressive stress in angles and web $= \frac{5.2}{7} \times 3 =$ 2.2 tons per square inch.

Tensile stress in flanges $= \frac{5.2}{7} \times 4 = 2.9$ tons per square inch.

Thus, such stresses are actually in existence, and are in addition to any working stresses which the bars are designed to take. This points to the necessity of having a checking gauge in all bridge-yards. The gauge would need to be made from a stiff, mild steel section—say, of channel steel—about 50ft. long, marked and carefully graduated from a standard steel tape when the temperature is normal—say, 50 deg. Fah. The wood templates should then be taken to the gauge, and any variation from the known length of what these should be, would be carefully corrected in the marking of the material for drilling. Such a gauge is actually in existence at a certain works in the Midlands, although its usefulness and purpose is not fully realised.

When steel strips are used as templates, these vary in length exactly as the material itself which is being marked, and this is a very strong point in their favour for accurate work.

EFFECTS OF DIFFERENT METHODS OF HOLING MATERIAL.

A similar effect to that due to the variation in templates in producing permanent initial stress is got by combining work which has been drilled, along with punched and rimered work, which is still considered good practice. It is supposed that rimering takes away any ill-effects of punching. This is not so, however, for during punching the material round the hole is seriously compressed, which is plainly demonstrated by the crumbling away of the scale in the vicinity of the hole and by a decided lengthening of the bar. Rimering out the holes afterwards does not prevent the lengthening of the bar, which has; of course, already taken place, though it may be less than it would otherwise be, owing to the fact that with punching full size, a bigger hole would have necessitated a bigger compression; and at the same time a portion of the ruptured material round the hole is removed. It is general to insist, where work is punched full size, that the clearance between the punch and the die be as small as is possible to ensure a hole practically parallel. As a matter of fact, if more clearance is allowed, though there would be more taper in the hole, yet the material would not be fractured so much, nor would the bar be elongated to the same extent.*

In the manufacture of a plate girder, say, of a length equal to 30ft., with main angles 3½in. × 3½in. × ⅞in., and ⅞in. diameter rivets, 4in. pitch, it may be found most convenient to punch and rimer the angles, but to drill from the solid plates to which they are attached. This is very bad practice. During punching the angles have quite conceivably lengthened about ⅛in., and when the girder is built a permanent compression will exist in the angles, and a corresponding tension in the flanges or web plates to which they attach. For such reasons it is plain that work should never be partially punched or drilled, but that the manner of holing should be common throughout.

EFFECTS OF COLD BENDING AND STRAIGHTENING.

It is quite a common thing for sections of all kinds, but more particularly those in which the material is one-sided—such as angles, channels, and zed bars—to arrive from the mills very much curved or distorted. This curling is partly due to the cooling of the material at the mills immediately after leaving the rolls, and the shape taken up will be found to be what would be expected from the varying time taken to cool the unequally disposed material.

Fig. 23 shows a 12in. by 3½in. channel. It will be seen that there is at least twice the material on the web side of the neutral axis than on the other—consequently, this part, taking longer to cool, has the effect of curving the channel inwards as shown. It will be found in practice that the amount of bending shown is in no way exaggerated. When this channel is straightened a stress will be produced in the extreme fibres, which may be assumed to be equivalent to that which would be produced if the channel had been bent to this curvature after having been previously perfectly straight.

Let R = the radius of curvature $= \frac{1\frac{1}{2}^2 + 12\frac{1}{2}^2}{\frac{1}{2} \times 2}$ ft.
$= 156.5$ft.
$= 1878$in.

Let M = the bending moment produced, due to straightening.
I = moment of inertia of the section.
E = the modulus of elasticity.
y = the distance of extreme fibres from the neutral axis = 3½in. − ⅞in. = 2⅝in.
f_p = the stress produced in the extreme fibres.

$R = \frac{E\,I}{M}$, and $M = \frac{E\,I}{R}$,

also $M = f_p \frac{I}{y}$

Then $f_p \frac{I}{y} = \frac{E\,I}{R}$ and $f_p = \frac{y\,E}{R}$.

$f_p = \frac{2\frac{5}{8}\text{in.} \times 13{,}400}{1878} = 18.7$ tons per square inch tension at edge of channel leaf, acting in tension only at the instant the blocks of machine are in action.†

These figures show that a very high stress is produced in the outside fibres during cold bending, and this is conclusively borne out in watching the actual process of straightening. The scales fall off the bar immediately behind the points where the blow is given, and prove that an intense stress has been produced. More trouble should be taken at the mills to ensure that the very minimum of winding and bending takes place during cooling, and material bent beyond a certain reasonable limit should be rejected for structural work.

Cold bending for connecting plates, fish plates, &c., is quite common in all girder yards. It is quite usual even to bend important covers at vital joints this way. Take, for instance, the flange cover-plate, which would be necessary at such a point as "A" in Fig. 7, where a sketch is given of a large bridge truss, and the joint between the raking end post and top boom is discussed. The cover plate would have to be bent through 45 deg.—see Fig. 24. If the plate was not more than ½in. thick it would be quite usual to bend it whilst cold. The extreme fibres at the point of bending are not only elongated or compressed, but also a permanent elongation will have taken place at the corner due to the whole extension taking place in about 3in. That a permanent set has taken place is proved by the fact that nothing more is needed actually to break the plate than to bend it back again. A plate so bent has lost all, or nearly all, its strength in tension or compression as a flange cover.

Cold bending of covers or connecting plates should never be allowed. Nevertheless, it is known that mild steel will stand a certain amount of cold working, and that its crystalline structure under such treatment undergoes such a change as makes it into a material of increased brittleness, of a raised elastic limit, and a higher breaking load. (See Cecil H. Desch in "Transactions of the Institution of Engineers and Shipbuilders in Scotland, Vol. 57.) It will be remembered, too, that wire-drawing is carried out cold, and that each draw gives a higher tensile strength. But an amorphous modification of the material has taken place, and particularly the resistance to fatigue is considerably reduced. Again, there is a vital difference between such cold working and the cold straightening mentioned, where a very severe stress is produced; and similarly with regard to bending plates cold, where the material at the root is to all intents and purposes irretrievably fractured.

"THE ENGINEER" Fig. 23. SWAIN Sc.

EFFECTS OF ERRORS IN JOINTS OF BOOM PIECES AND IN LENGTHS OF MEMBERS.

Facing of the ends of large boom pieces in heavy bridgework is mentioned in Section I. (Part II.) in connection with good butt joints, bad setting at the facing machine—in fact, the slightest inaccuracy at that stage is also responsible for serious initial bending stress in the boom pieces when the structure is built. Such a point as this is missed entirely by the average inspector, who assumes that the accuracy of the machine and the carefulness of the operator ensures good work at this stage. It is asserted here that many slight variations in the angles of facing do actually occur in practice at such machines, and that the utmost watchfulness should be exerted to prevent such.

Let it be supposed that the end of a boom member—say, 30ft. long and perhaps having a 3ft. web—is faced 1/16in. out—see Fig. 25. Drifting would be carried out at M, N, and O, and the point P would probably be raised slightly, until in some such way an apparently good butt would be manœuvred at the point N. The result is practically what would be obtained by slacking the drifts and tackle at M, and then by drawing the end of raking post M N in a direction at right angles to the boom piece, anti-clockwise. This would mean a movement equal approximately to $\frac{30}{3} \times \frac{1}{16} = \frac{5}{8}$in. The butt at the top will now have been made good, and drifting is again resorted to at the point M, so as to make the holes good there. This drifting is the same as if a load were applied at the point M at a leverage of 30ft. until the boom piece is deflected backwards ⅝in. Assume that the section of boom piece is uniform throughout, and that the webs are 3ft. deep, with single flanges ¾in. thick, then the equivalent load W at the end of the 30ft. boom piece equals $\frac{5}{8} \times \frac{3\,E\,I}{L^3}$, and the bending moment resulting from it will be equal to $\frac{5}{8} \times \frac{3\,E\,I}{L^2}$.

The resisting moment equals $\frac{f\,I}{y}$, where f = maximum fibre stress, and y = distance from neutral axis to extreme outside layer = 18¾in.

$f = \frac{y \times 5 \times 3\,E\,I}{8\,L^2 \times I} = \frac{18\frac{3}{4} \times 15 \times 13{,}400}{8 \times 360^2} =$ nearly 4 tons per square inch.

As it is quite probable that the allowable working stress in such a compression member would probably not be more than 4 to 5 tons per square inch, it will be seen that it is quite easy to double the safe working stress by injudicious drifting.

It is asserted here that in many large bridge trusses the lengths of verticals and diagonals have been known to vary as much as ½in. from the true length over the intersections. Inspectors are generally satisfied if the boom pieces answer to their true calculated overall lengths (overlooking the fact that the holes fix the true lengths), and if the butts are good; the essential feature of initial stress caused by the members being drifted and pulled together into one complete frame being quite ignored.

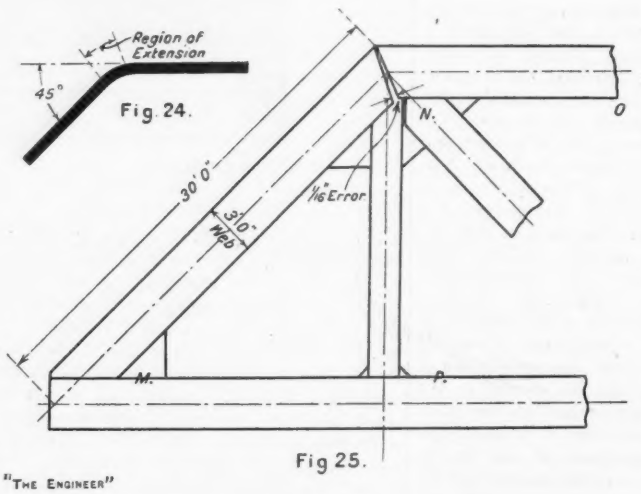


Fig. 24. Fig 25. "THE ENGINEER"

Fig 26. SWAIN Sc.

DISTORTION EFFECTS OF PRESSURE RIVETING.

Machine riveting, generally so strongly advocated,

* The author understands that in American yards it is usual to use a bolster with a convex top, and that this greatly minimises the distortion in the punched bar, and also the consequent elongation.

† Only a portion of this stress is probably permanent, this portion being exerted to restore the channel to its original bend, the remainder being assumed to be expended in a hardening of the crystals. Mild steel has a power during cold working of readjusting its molecules to a certain extent, and of thereby raising its ultimate tensile strength. It must be remembered, however, that in straightening such a bar it would be necessary to bend the same in the opposite direction by an amount approximately equal to the original curve. This subjects the material to even more severe treatment than that calculated. If the material is bent cold to such an extent that it will not return when free to its original bend, by the very meaning of the term it must have been stressed beyond the elastic limit. It is only the re-adjustment of the molecules which can then give the material any real strength.

is the cause of unknown initial stress, quite apart from that dealt with in Section I. Anyone familiar with a bridge-yard knows how pressure riveting twists and bends the work it is applied to. It is due to the following reasons :—

(1) Heat from the rivets, by conduction along the iron, lengthens that portion of the member to which the rivets are being applied, and also, by stretching the material round the holes adjacent to the hot rivet, increases their diameter.

(2) The pressure which is applied to close the rivet —say, 30 tons—first causes a bursting pressure in the hole, and then nips and compresses the surrounding material to the rivet as soon as the head is made. The material round the hole is softened by the heat, and, consequently, is more readily compressed, and an extension in the member along the line of rivets takes place. Now, this extension is not just temporary, as is generally supposed, for the holes which have been increased in size by the heat of conduction have now been filled by rivets under pressure.

What actually happens is that a girder in being riveted thus will bend to one direction with the riveting of, say, the top flange, but that this will be partially righted by a tendency to bend in the other direction when the bottom flange is being riveted. The nett result is to cause permanently a slight distortion, a certain lengthening, and a compressive stress in the member when it is brought into position in the structure for which it is intended.

FAULTS IN ROLLING.

A common fault in the rolling of angle sections is that they are often finished acute—see Fig. 26. If received into a bridge-yard in this state—as they very often are—they can only be opened out cold, and under pressure. This is of course disastrous to the material at the root of the bar.

There are many more practices in vogue, and many oversights occurring in manufacture, which will present themselves to different minds, but it is impossible to mention them all here. The writer can only hope that this article will be helpful in bringing about more conformity in the treatment, design, and manufacture throughout of structural steel work.

These notes were written three years since. A correspondence took place in the columns of The Engineer towards the end of last year under "A Plea for Up-to-date Bridgework in the United Kingdom." This correspondence suggested to the writer that the above article might be read with interest at this time. He is aware that some of the examples used have not been discussed as fully as they might have been, that some of the assumptions may not be strictly correct, and that some people may say that there is no time for this sort of thing—that it is altogether too academical.

There are many reasons why at this time the whole structure of our commercial and manufacturing methods should be thoroughly investigated and put on a more scientific and better business footing. Design is too often done by "rule of thumb," and workshop methods are too often devoted towards giving finished appearances, rather than seeing that the fundamental principles of design are not abused. Specifications are altogether too loose, and their fault is, like that of the inspectors who are appointed to see them carried out, that too much importance is placed on the individual aspect of requirements and workmanship.

Considering particularly the structural trade at the end of the war, there will be a vast field of new work, both in the Colonies and in devastated countries. Wages and cost of production have risen abnormally high in this country, and it is doubtful as to whether they will fall again in any marked degree. Other countries will be eager to accept this work, and will be better prepared than the home country, with its war-worn plant. If, then, the cost of production shows little chance of falling, and we make no change in things at home, we may resign ourselves to the position of losing the world's markets.

Some suggestions may be derived from the above article as to how we may really cheapen production.

As regards workmanship, all factors of safety are of no avail if this be faulty. If we are to cheapen the work, only the real necessities must be imposed on manufacturers. To explain the meaning of this, butting of joints, or facing shafts of columns so as to make them bear on base plates, &c., are either necessary or unnecessary. Seeing that enough rivets are generally put in to take the full load, time and money in making such butts are wasted.

We must get down to the essential features of design, and time must be found and given to those whose duty it is to investigate and to work out same. It is no use working with a factor of safety of 4, if in certain small parts it is only 1 or 2. It is far sounder to have a lower factor of safety, and to have confidence that this is not reduced in any part of the structure.

Compare the time which a designer might spend on investigations with the material that it is quite possible for him to save. At the present price of finished structural work, a designer might economically spend five weeks to save one ton of material. In as many hours he could often save tens of tons.

This subject should be approached with the awakened interest that the war is giving to all industries in this country. Both practical and theoretical questions with regard to it must be investigated, and not simply set aside. Real progress will then be made, and this country will have nothing to fear.

SOCIETY OF CHEMICAL INDUSTRY.

No. II.*

INDUSTRIAL FUEL FROM GASWORKS.

A paper was read by Mr. E. W. Smith, of the Birmingham Gas Department's Laboratory, on "Industrial Fuel from Gasworks." The industrial world was awakening, he said, to the importance of the gas industry as a relatively untapped source of fuel of the most useful and nationally efficient kind. During the year ended March, 1917, the quantity of town's gas made in Birmingham was eleven thousand million cubic feet, ten thousand million being obtained from the carbonisation of 800,000 tons of coal, and the remainder from carburetted water gas produced from five million gallons of petroleum oil and 37,000 tons of coke. Of the gas sold, nearly 80 per cent. was used for heating and power purposes domestic and industrial. The national aim should be so to use the coal supplies that the maximum amount of value was obtained. As a matter of fact, it paid to carbonise coal rather than burn it. Briquettes were comparatively little used in this country, largely because they were too dense to burn without a large amount of induced draught and because of their cost. Results were now being obtained, however, indicating that these troubles had been overcome. The new briquettes were hard and porous, and required little induced draught, burning regularly without the dripping of pitch, which was objectionable, in an open domestic grate and giving an almost flameless incandescent body of fuel. The public would certainly hear more of this fuel in the near future. With regard to low temperature carbonisation, there seemed to be no general agreement as to the object of its commercial development. The differences in the results obtainable were very great, and those who were in close touch with what had been done agreed that so far no really satisfactory results had been obtained. It was questionable whether there had been sufficient competent research work carried on, and an attempt should be made by the Government, or some competent independent authority, to set up a strong committee to go into the whole question.

In the discussion, the President said that negotiations were in a fairly forward state with regard to the taking over of land for the erection of experimental works by the Fuel Board, so the matter would receive the attention it deserved. Professor Louis expressed pleasure in hearing that briquetting was to receive more attention in connection with the utilisation of slack. It was one of the most pressing economic questions of the moment. Three-quarters of the patent fuel made in this country was exported. When coal control became an actual fact, and not a mere phrase, coal depôts would probably be established at the big centres of consumption, and the proper thing would then be to have adjacent patent fuel factories to deal with the inevitable big accumulation of dust. When people spoke of getting the maximum value out of coal, they ought to be quite clear as to what this meant. Money values might not be the best for the country at large, and many complex varying factors came in. Mr. W. J. A. Butterfield, referring to the amount of inert gases in coal gas, said some limit ought to be fixed, and he thought the industry would shortly take steps to put this limit at 10 per cent. If water gas was to be used more extensively in coal gas for public supplies, its amount should be uniform, not 5 per cent. one day and 50 per cent. another day.

INDUSTRIAL USES OF TOWN GAS.

Another paper dealing with gas was entitled "The Industrial Application of Town's Gas," by Mr. C. M. Walter, of the Birmingham Gas Research Laboratory. The development, said the author, which had taken place in the last few years in the application of town's gas for manufacturing purposes signified that the future of that form of fuel would largely depend upon its use in that capacity as a substitute for solid fuel. A good deal depended upon the heating efficiency of the gas. Even where there was no advantage in that respect over solid fuel, gas had competed favourably owing to economies in other directions. The heating efficiency of the gas furnace would, undoubtedly, be increased, as up to the present little had been done in the way of conserving the heat carried away in the waste gases by the employment of regeneratory systems in furnaces designed for gas use, and it seemed possible that the heating efficiency might be so increased as to enable town's gas to compete with solid fuel on a fuel cost basis alone. In the Birmingham metallurgical industries gas furnaces had made great strides in the last two years. In the annealing of brass stampings the work was done twice as rapidly as when solid fuel was used, and in the case of iron castings the product was superior. Pyrometry was still rather a weak point. In the discussion, Mr. A. E. Tucker (Birmingham) said, that in London, 800 tons of brass were being melted down weekly in gas furnaces, in this work the effective control of the heat being a matter of importance. With ignorant workmen, he had known a loss of 10 per cent. of zinc, and much brass spoilt. In the course of his reply, the author stated that there were now, in Birmingham, 17 miles of high pressure gas mains at 12 lb. to the square inch.

* No. I. appeared July 27th.

CALORIFIC VALUE OF INDUSTRIAL GASES.

Mr. W. J. Pickering, also of the Birmingham Gasworks, read a paper on the "Calorific Value of Industrial Gaseous Fuel," a subject which he said had in the last few years become of increasing importance. The test for illuminating power was now of quite secondary significance, and it would probably be discarded in the near future, at any rate, as an official test. The author gave the results of several years' experience in testing the calorific power of gas, describing the apparatus and methods adopted. A calorimeter which would give a continuous record of the total heating value of the gas would be a valuable instrument in large works, and one would, he thought, be placed on the market before long. Though its cost would necessarily be higher than that of the "net" value recorder, its accuracy and sphere of usefulness should more than outweigh the difference. There were good reasons for adopting the term "total heating value," or merely "total heat," in preference to the old "gross value."

ATMOSPHERIC NITROGEN.

Two papers dealing with the utilisation of atmospheric nitrogen attracted the largest audience of the meeting, no doubt because of the importance and comparative novelty of the subject, and from the fact that there are competitive systems. In the first paper Mr. E. Kilburn Scott (Birmingham) dealt with the "Manufacture of Synthetic Nitrates by Electric Power." For many years, he said, the alternating-current plant used was of the single-phase type, but it proved faulty, because a large proportion of the air passing could not come in contact with the arc. Three-phase plant, however, was now practically universal, the Kilburn Scott type being the only one that had been developed as a self-contained three-phase unit. Such a furnace required only three electrodes. The chemical reaction being reversible, it was important to chill nitric oxide gas quickly. While with single-phase furnaces this could only be done by blowing excess air through the furnace, it was effected in the Kilburn Scott furnace largely by having a boiler to form the roof. Comparing the result, the author said that the generally assumed yield from single-phase furnaces was half a ton of pure nitric acid per kilowatt year, while tests made in three-phase plant showed that yields 50 per cent. greater were obtainable. Where the acid was intended for the manufacture of ammonium and calcium nitrates, a 25 per cent. acid was strong enough. Describing the furnace the author said the absorption chambers are of the rectangular form, and built together in one block of acid-proof bricks, the party walls being pierced with small holes. Every second chamber is filled with quartz pebbles to offer a large absorption surface, and the others are empty to act as oxidising chambers. The outer walls of the chambers are made tight to liquid and gas by a coating of acid-proof asphalt. Mr. Scott discussed at some length the comparative merits of his direct process, viz., making nitric acid from air by the electric arc flame, and the indirect processes, viz., making nitric acid by means of calcium carbide, calcium cyanamide, ammonia, and catalytic action, pointing out that, as regards first cost of plant, the indirect method was not in the running at all. The argument was often raised, he said, that we cannot generate electric power cheaply enough for the direct process, though it was a fact that, for some years before the war, electric energy had been sold in this country at lower rates than at Niagara. The problem of cheap electric power would be solved for this country in the future by the establishment of super-power houses, and some of 120,000 kilowatts each were already projected. There would also be coke oven gas, a battery of 100 modern coke ovens being estimated to yield 3000 or 4000 horse-power. In replying to an interesting discussion, in which the subject of the relative costs per ton of nitric acid by the rival processes was prominent, Mr. Scott said that we had been held back in this country by groups interested in the Chili business, but after what the late Minister of Munitions had recently said it seemed that the air nitrate industry must now go ahead in Britain.

This paper was followed by one on "The Synthesis of Ammonia and its Oxidation to Nitric Acid," by Mr. Edward B. Maxted. The first step in the industrial synthesis consisted, said the author, in the choice and adoption of suitable methods for the manufacture of nitrogen and hydrogen. Moreover, it was absolutely essential that these gases should be obtained not only as economically as possible, but also in a state of practically absolute purity, free from catalyst poisons of every nature. The nitrogen-hydrogen mixtures produced by existing processes usually contained an appreciable quantity of catalytically poisonous carbon monoxide, and his firm had found it expedient to manufacture the gases separately, and to mix them in the proper proportions as and when required. Having described at some length how this was done, the author explained that the gases compressed at 180 atmospheres were passed alter-

nately over a heated catalyst—preferably iron containing traces of other bodies—and through a refrigerating system in which the ammonia was condensed. The key to the economic working of the synthesis, he pointed out, was the cost and purity of the hydrogen. Reference was made to the pioneer work of Heber, whose methods had been subsequently developed by the Badische Anilin und Soda Fabrik, in Oppau, near Ludwigshafen. No less than about one million tons per annum of synthetic ammonium sulphate were now being made by this company, but the published information regarding this process was extremely scanty. After describing at some length the plant employed, and stating that the reaction vessels are usually placed in pits out of doors for fear of explosions or bursts, the author said that, under normal conditions, the cost of synthetic ammonia should be from £10 to £12 per ton, and after discussing the costs of the other processes he expressed the opinion that, from the point of view of power and material, the direct synthesis of ammonia was more than twice as efficient as the cyanamide process, and more than six times as efficient as the arc process. Despite various charges, which were heavier than in the other processes, the direct synthesis of ammonia, accompanied, where necessary, by its subsequent oxidation to nitric acid, presented, he said, by far the most economical method of fixing nitrogen at present known, and if only by virtue of the urgent need of the land for cheap, abundant, and non-seaborne fertilisers, it deserved every attention from a standpoint of national economy.

SEWAGE PURIFICATION.

"A *Résumé* of the Present Position of the Activated Sludge Process of Sewage Purification" was the title of a paper given by Mr. E. Ardern, of the Manchester Sewage Works. The details of this process worked out at Manchester are to be found in previous publications, and on the present occasion the author made it his main object to draw attention to what is being done, especially in America, in the development of the process, which, simply described, consists in treating the sewage with compressed air, all filtration being done away with. A new large scale unit is now being laid down at Manchester, and its constructional details were given in the paper. Among other installations, those at Salford, Worcester, and Stamford were described, as also several which are at work in America. Some trouble had been caused, the author said, by the excess of trade effluent which in Manchester, as in other industrial centres, had increased owing to war-time activities. The outstanding feature of the activated sludge process is the recovery of a considerable proportion of the total nitrogen contents in a form available for agricultural purposes. At Milwaukee the manurial yield of the sludge was put at 25s. per million gallons, and contracts, it was stated, had been let for the whole production. The actual cost of the process would be governed by the cost of available power, and full advantage should be taken of the value of the sludge to reduce the costs. Several speakers ventilated their views in the discussion, some of the points insisted on being that the process was still only in the experimental stage; that trade waste would always be of great importance; that the sludge was very difficult to de-water, and that all corporations did not wish to become manure manufacturers.

ARTIFICIAL SILK.

The meeting then turned to the consideration of "The Artificial Silk Industry," a paper on this topic being given by Mr. T. P. Wilson, who also showed a large number of specimens illustrating the manufacture and the various finished products. Artificial silk, he said, was now in such general use for producing a large number of textile materials, that there could be no doubt, whatever, that it had made for itself a permanent position in the world of industry. There were three main processes in use, viz., the nitrocellulose, the cuprammonium, and the viscose. The last was entirely British in its origin and development, and, although the manufacture was more complicated than that of the older processes, it was the opinion of those competent to judge that it would ultimately supplant them. There were now about thirty viscose silk factories in the world, Norwegian spruce being the general raw material used. How this was converted into alkali cellulose and further into cellulose sodium xanthate by the action of carbon bisulphide at the works of Messrs. Courtauld, Coventry, was fully described by Mr. Wilson in the course of his paper.

FINE CHEMICALS.

Mr. E. W. Mann contributed a paper on "The Future of the Fine Chemical Industry," dividing his subject under the three broad headings—Research, Manufacture, and Markets. The State Committee on Research had advocated the extension of the technological departments already in existence at some of our universities, but he thought there were advantages in the scheme proposed by Sir Thomas Barclay for the establishment of State research laboratories under joint manufacturing and academic control, working on industrial problems and throwing the results of their work open under licence or royalty. One advantage of such a scheme would be to prevent overlapping and waste, and it would tend to the economical utilisation of talent. It was a fact that quite recently five firms had done the research work for the production of a certain dye with antiseptic properties. Was this multiplication economic? At the present time it was easy for certain manufactures to be carried on in a small way, and yet profitably. But what chance had they on such lines in the future? Salicylic acid was now possibly manufactured by a dozen or more firms in this country, with an entire output barely sufficient to supply our home needs; they might compare this with the output of a single German house before the war, which was greater than all put together. Was there room, he asked, for so much individual effort, and should not some steps be taken to concentrate production, and thus to reduce manufacturing costs to such a point as would enable this country, eventually, to compete with the old-established and large scale German plants. The American practice of the interchange of manufacturing costs, either by a State department or by a trade association under the seal of secrecy, was recommended by the author, who coming finally to the question of markets, expressed the opinion that a tariff was essential for a time, at any rate, to prevent the inevitable dumping. The tariff imposed should be high enough to prevent this, but it should not be so high as to free the manufacturer from the stimulating effect of external competition; such a course would only produce an unhealthy hothouse atmosphere, and would not conduce to our success in neutral and colonial markets.

METALLURGICAL QUESTIONS.

At a special session a series of short papers were presented dealing with metallurgical industries, and in introducing these, Professor Turner (Birmingham University) pointed out that the population of Birmingham, as a business centre, was about equal to that of half Belgium, and the staple industries, such as coal, iron, steel, copper, brass, aluminium, refractories, and engineering, were all such as contributed to the national wealth in the days of peace and to the national strength in the days of war. The production of iron and steel was being limited by the moderate supplies of ore, but the output was still equal to that of the whole of the United Kingdom a century ago. The wrought iron trade still flourished, and the copper industries, though there had been no new scientific discoveries, had shown an expansion of output. The researches conducted in the University by Dr. Hudson had been found of considerable value by local brass manufacturers. The nickel industry had been busy, but the greatest expansion had been in the aluminium trade, where the output of only one of several Birmingham factories was now equal to the whole of the world's output a dozen years ago. Referring to malleable cast iron, Professor Turner said, that on account of the shortage of best class raw material, efforts were being made to introduce better scientific methods, so as to enable them to use a wider range of pig iron, and thus, permanently, benefit the industry which was one capable of considerable extension.

Among the papers given were "Cartridge Brass," by Dr. H. W. Brownsdon; "Rapid Analysis of Aluminium Alloys," by Mr. J. H. Stansbie; "Superheating of Slags and Metals during Refining," by Mr. J. E. Fletcher; and "Carbonless Alloys," by Mr. J. Kent Smith. Exhaustion of space prevents further reference to these papers, and for the same reason, one or two other papers of special, rather than general interest, notably that on the "Chemistry of Vulcanisation," by Dr. Twiss, of the Dunlop Rubber Works, must be passed over.

VISITS.

At the conclusion of the business programme, visits were paid by parties of members to the Corporation's Gas and Sewage Works, the King's Norton Metal Company's Works, Messrs. Kynoch's Works, H.M. Government High Explosives Works—Managers, Messrs. Chance and Hunt—and the Dunlop Rubber Company's Works. Admission to these works, mainly engaged on munitions, was limited to members of British birth, and, in addition, all names had to be submitted and approved. Except, however, in the case of the Dunlop Company, there was no appeal to members not to apply for admission to works in the processes of which they took any interest, and, therefore, it may be said that the strictures passed by Dr. Dunn last year at Edinburgh on this point have already borne fruit. Those chemists who were fortunate enough to apply in time for the visit to the new High Explosive Works saw much to interest and impress them, but as, quite naturally in the circumstances, an embargo was placed on the publication of their experience, we shall, of course, refrain from saying anything more.

AN ATMOSPHERIC COLLIERY WINDING ENGINE.

The interest that was displayed in the description of the old colliery pumping engine, contained in Mr. W. T. Anderson's paper, read some time ago to the members of the Manchester Geological and Mining Society, shows that there exists among engineers a feeling of veneration for these old relics of steam engineering practice, many—too many—of which have been permitted to end their days of usefulness ignominiously, by relegation to the scrap heap. It is a matter for regret when such old engines are destroyed without some record being kept of their origin, peculiarities and duties, for if present-day engineers find little that is of service to them in their construction, they will at least learn how our ancestors overcame difficulties by means of rude and inexpensive appliances.

Fig. 1—OLD BEAM ENGINE AND COLLIERY WINDING GEAR AT MADELEY

The engravings on this and the next page, and Figs. 6, 7, 8, and 9 on page 98, illustrate an old colliery engine and winding gear, which until a few years ago was still doing useful work at a mine belonging to the Madeley Wood Company, at Madeley Market, Shropshire. This is, no doubt, one of the engines referred to by Mr. Henry Davey in his paper read before the Institution of Mechanical Engineers in 1903. The author said that "at that time—1780—there were sixteen large engines at work in connection with the coal works and furnaces of the Coalbrookdale concern at Ketley, Dawley, Madeley, and Coalbrookdale, chiefly for pumping." A photographic reproduction of a winding engine built at Coalbrookdale about 1790 was included in Mr. Davey's paper, from which it seems certain that the engine under notice was by the same designer. It is of the atmospheric type, with a single open-ended vertical cylinder, 3ft. diameter by 4ft. stroke. Steam for driving was supplied, latterly, at about 4 lb. pressure per square inch, by means of the egg-ended boiler shown immediately to the right of the engine-house in Fig. 2, but was formerly obtained from the haystack boiler seen on the extreme right-hand of this view. The building in which the engine is housed can lay claim to no architectural pretensions. It has two storeys and a protruding platform extending out from the upper floor and giving access to the outer end of the beam. A singular feature about some of these old beam engine-houses is the lack of "elbow room" provided. Although situated in a place where a few square yards of land, more or less, was of the least possible consideration, the engine-house at Madeley is very cramped, and although a cast iron staircase is provided between the two floors, the engine

driver would have to be of slight proportions to obtain access to the valves in the foundation.

The cylinder is a single casting shaped somewhat as shown in the sketch—Fig. 3—and is carried on four cast iron pillars bolted to the foundation of the building. The piston is of cast iron packed with hemp, which is secured by a junk-ring and set screws, the packing being kept steam-tight by the introduction

Fig. 2—ENGINE HOUSE AND BOILERS OF THE MADELEY ENGINE

of a solution of cow dung on top of the piston. We have not been able to ascertain what the particular merits of this solution are for the purpose to which it was applied, but it was certainly very generally used. The employment of water on top of the piston would have the advantage that in case the piston packing was not tight the leakage of water past the piston would help somewhat in producing a vacuum

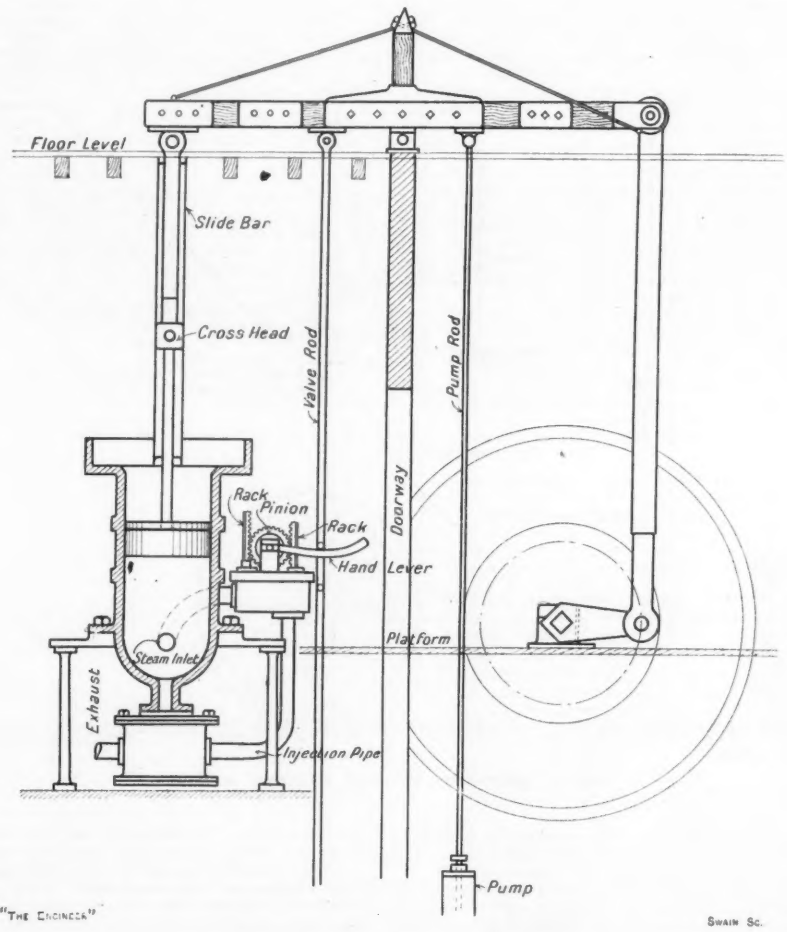


Fig. 3—ARRANGEMENT OF THE MADELEY ENGINE

below it. The base of the cylinder is hemispherical and there are two branches, one somewhat above the bottom, for the steam inlet, and the other for the admission of condensing water and exhaust alternatively. To this latter branch a box or hot well—Fig. 3—built up of cast iron plates, is bolted, in a somewhat similar manner to that employed in the atmospheric pumping engine at the Moira furnaces, illustrated in Mr. Davey's paper. We were unable to investigate the internal arrangement of this vessel, but it has three branches, one on top for connection to the cylinder, and one on each end, with a self-acting flap valve for the exhaust. Considerable importance attaches to the hemispherical shape of the cylinder base. This enabled the water of condensation to be completely drained from the cylinder prior to the admission of the steam on the next working stroke. In some of the old engines with flat-bottomed cylinders the fuel consumption was unnecessarily high, owing to much of the steam being condensed as it entered the cylinder by coming into contact with water having an exposed surface equal to the area of the cylinder. Two vertical cast iron slide bars—Fig. 4—extend from the top of the cylinder to the floor level above. These form the guides for the piston-rod crosshead, the rubbing surfaces of which are of wood. Two vertical wrought iron straps connect the crosshead to one end of the beam above. The beam—Figs. 3 and 8—is of oak, strengthened by cast iron side plates and tie-rods extending from each end to a cast iron cap secured on top of a central oak upright which in turn is driven into an iron casting bolted on top of the beam. The beam oscillates about a trunnion, carried by brackets on the walls of the engine-house, and from the other extremity is pivotally suspended a long and heavy cast iron connecting-rod, which in turn drives a crank on a square shaft forming part of the winding gear, which is seen in Figs. 2. Two other vertical rods are pivotally suspended from the overhead beam, one outside the house, and shown in Figs. 3 and 6, actuating a pump which supplies water for condensation and boiler-feeding purposes, to a cast iron tank on the top floor. From this tank the water flows by gravity to the engine cylinder and to the boiler for feed, the head of water being sufficient to overcome the pressure of 4 lb. in the boiler. The pump is of the bucket type. The other rod referred to is inside the building—see Fig. 3—and serves to actuate the steam and water valves, of the plate and pin type, which are situated between the cylinder casting and the doorway on the first floor—Fig. 3. These valves are actuated, jointly, by means of a toothed pinion and racks, the movement

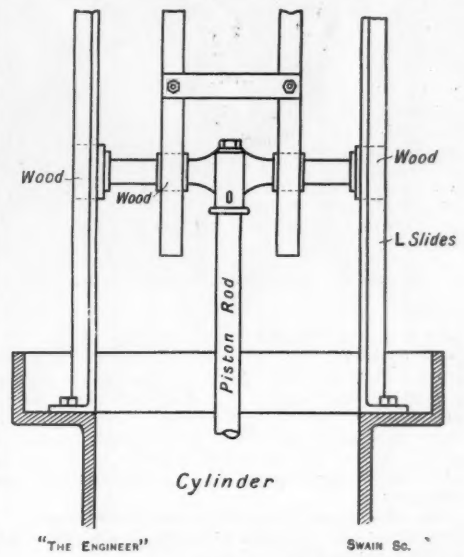


Fig. 4—SLIDE BARS AND CROSSHEAD

of a lever by trip mechanism or by hand in one vertical direction opening the steam valve and closing the water injection valve simultaneously, or *vice versâ*. This part of the mechanism is probably not as old as the engine itself, and is very similar to that used on the Moira engine above referred to. To make one revolution of the winding drum seven working strokes of the engine are required, and these, we were told, were made in three minutes. When the cages were reaching the end of the haul the driver had to stand by and shut off the steam by means of the throttle valve, shown on the left-hand side of Fig. 9, and the reversing of the engine was similarly performed by hand. Warning of the approach of the cages to the top or bottom of the pit was given by worm gearing actuating a gong in the engine-house. The vertical rod above alluded to, being suspended on the cylinder end of the beam, cut off the steam and admitted water at the top of the upward stroke and on the downward stroke shut off the water and again opened the steam,

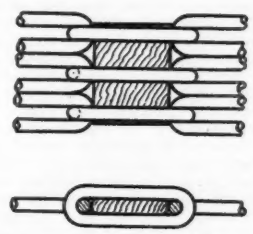


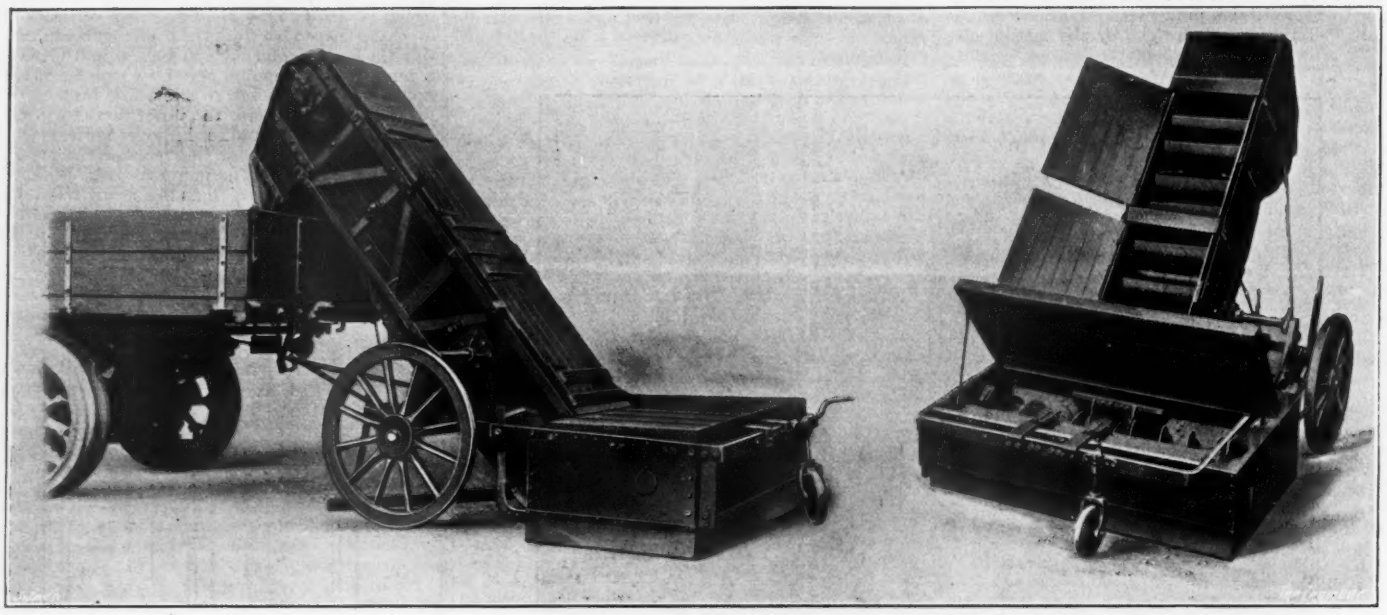
Fig. 5—CONSTRUCTION OF WINDING CHAIN

but the tripper mechanism could be thrown out of gear and the operations carried out by hand, if desired. The upward movement of the piston was, therefore, brought about partly by the pressure of the steam under the piston, equivalent to about 1¾ tons, and partly by the weight of the solid cast iron connecting-rod, which is probably several tons; while the downward stroke was effected by the pressure of the atmosphere above, equivalent to nearly 2½ tons with a vacuum of 12in. The beam is 14ft. long between the centres of the piston link connections and the connecting-rod. At the connecting-rod end, two cast iron plates are bolted to each side to form a fork, the plates being connected by a wrought iron gudgeon pin, about 4in. diameter, and held in position by a split pin. The end of the cast iron beam is lined with brass secured by keys and cotters.

The winding gear is operated by means of a spur pinion on the square shaft, meshing with a wheel on the drum shaft, a large cast iron fly-wheel is secured on the first motion shaft and a brake drum on the

ROAD SWEEPING MACHINE

F. WALTERS AND CO., BILTON, RUGBY, ENGINEERS



second motion shaft. Two winding drums are provided for the two pit shafts, one for letting down a cage, while the other hauls up the other. As the mechanism was designed and constructed long before wire ropes had been thought of, chains were employed. These are made of wrought iron in triplicate, as shown in Fig. 5, and are connected together by means of stout oak wedges driven through the alternate sets of links.

The photographs from which our illustrations have been made were taken for us by Mr. Charles Bartlam, Madeley, Salop.

A NEW ROAD SWEEPING MACHINE.

A NEW type of sweeping and loading machine for use on roads has been patented and put on the market by F. Walters and Co., of Bilton, Rugby. As will be seen from the accompanying illustrations, it is constructed in the form of a trailer for attachment to horse-drawn or power-driven wagons. It is geared to travel ordinarily at the rate of three miles per hour, but we are informed that it has been proved to be capable of working satisfactorily when drawn at six miles per hour. The working speed will, naturally, depend, however, on the condition of the road and the amount of refuse on the surface.

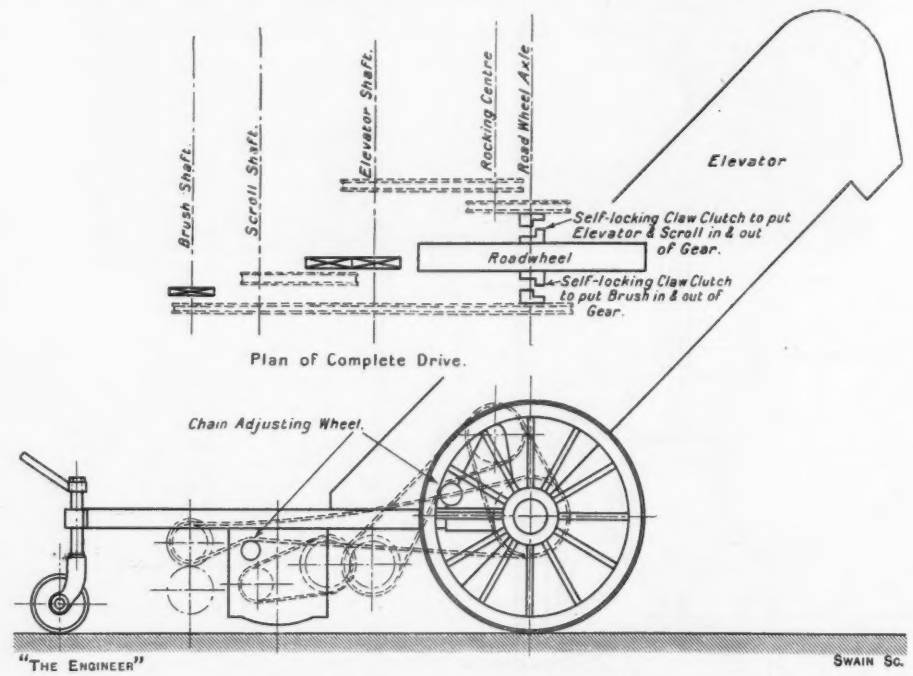
Messrs. Walters inform us that during the trials of the machine, which has been most severely tested under every kind of weather condition, it has been found capable of filling a two-ton wagon in six minutes when drawn by horses—this test being made under the worst possible conditions directly after rain on a macadam road—but that the usual time occupied, when the vehicle travels at the rate of three miles per hour, is from twelve to sixteen minutes, the actual time being dependent, of course, on the state of the road.

In order that its work may be performed equally effectively under any weather conditions, and dust removed without causing more than the minimum of inconvenience, the working parts of the machine and brush have been enclosed entirely down to the road surface.

From the illustrations it will be seen that the machine, to which its makers have given the name of "The Pioneer" sweeping and loading machine, consists of a steel frame supported on two road wheels, and a small trailer wheel situated in the rear of machine. On this frame, and situated immediately behind and over the main axle, are two malleable iron brackets. These brackets carry the conveyor casing and refuse trough, which are pivoted on an axle supported by them, this arrangement having been adopted in order to allow the trough to lift if it should come in contact with any solid obstruction in the road. The refuse trough is intended to travel as near as possible to the road surface without contact, and is situated immediately in front of the brush. The brush, which is 5ft. 10in. in length and 20in. in diameter, is driven in a direction contrary to the travel of the machine, by means of a chain and sprocket wheel fixed on the main axle, and it sweeps the refuse over a width of 5ft. 10in. direct into the refuse trough. In this trough revolve two helical scrolls, which are constructed of rubber. They are inclined in opposite directions so as to pass the refuse towards the centre of the machine and to force it over a small ridge which divides the trough from the boot of a conveyor. From this boot the refuse is taken by buckets, 24in. wide and mounted on endless chains, up the conveyor and delivered down a chute into the wagon. The small ridge between the trough and conveyor boot consists of a roller, which revolves slowly in a forward direction so as to prevent any accumulation on the ridge.

The brushes are constructed in short lengths and the brush axle is divided into three sections, fitted with universal joints suspended in two sliding central bearings in addition to the side bearings, so as to allow the central section of the brush automatically to adjust itself to suit the camber of road. The makers claim that in this way an even pressure of the brush throughout its entire length on the surface of road is obtained, and that there is thus no necessity to bring heavy pressure to bear on the centre of the brush in order that the ends may touch the road surface. This, they point out, should considerably prolong the life of the brushes, and, incidentally, prevent damage being done to the road surface. Furthermore, by setting back the central section of brush, the refuse swept forward by the two side sections is, it is stated, directed towards the centre, and greater efficiency is obtained.

The power to drive the machine is derived from two sprocket wheels on the main axle, which revolve with the road wheel, and both are fitted with throw-out gear. One sprocket drives the brush axle, and the other the conveyor, from the lower spindle of which the power is derived for driving the scroll axle in the refuse trough, and the small roller between the trough and conveyor boot. The hubs of the road wheels are fitted with ratchet attachments to enable the machine to work while turning corners.



DRIVING MECHANISM OF ROAD SWEEPING MACHINE

Messrs. Walters also claim that, as the only important adjustments are the regulation of the brush pressure and the height of the refuse trough, the machine can be entrusted to any attendant of ordinary intelligence. In fact, simplicity of construction, combined with the greatest possible strength whilst keeping the weight within moderate limits, have been the principal aim of the manufacturers. At the same time they, quite rightly, point out that one fact cannot be too strongly impressed upon all who control the working of these machines, and that is that "there is a limit of capacity to every machine," and that in these days when power-driven road brushes can heap the refuse from a large width of road into a narrow swath many inches deep, one can very easily exceed the limit of loading capacity. This results in the refuse being piled up between the brushes and refuse pan or even in front of the latter, and grave risk would be run of damaging the machine unless "a safety valve" had been added in the form of a shearing pin connecting the driving sprocket wheels. A device of this kind, which can be replaced in a few minutes if the breaking point has been reached, has, therefore, been embodied in the design.

The spreader in front of the refuse-pan is designed to level down any heaps of refuse, and by keeping the strain regular from one end to the other of the scrolls, to prevent blocking and ensure a regular feed to the elevating buckets.

The following comparative figures have been supplied to us by Messrs. Walters:—

At the present time, to clear a road one mile in length and 30ft. wide, an ordinary road-brush will be used for at least 2½ hours to sweep to the side of the road, say, twelve tons of refuse. Three wagons and six men will be required to remove this amount to the tip, and it will take six hours, on the average, to do the carting. Cost: One man with road-brush and horse, 2½ hours; six men with three wagons and three horses, six hours. With the "Pioneer" loading machine two men with two horses on a two-ton capacity wagon will fill the wagon in fifteen minutes. The wagon is then sent to the tip with one horse in charge of one man. A second wagon is filled in twenty minutes—an allowance of five minutes being made to unhook and refix the loader. The third wagon is also filled in twenty minutes, by which time the first wagon would have returned, and the mile of road would be cleared after each wagon had been filled twice. The work, therefore, would be completed in less than two hours with four men, four horses, and three wagons, and would effect a saving of 30½ hours in man's time and 12½ hours in horses' time. In this calculation the loading machine has been taken at fifteen minutes, which is nearly the maximum time reached in practice, and each additional ton per mile would add to the advantage gained by the loading machine. The amount of road surface swept and cleared in one hour's work behind a power-driven lorry, at six miles per hour, is estimated at 20,000 square yards. The weight of machine with its triangular attachment bar is given as being, approximately, 26 cwt.

RAILWAY MATTERS.

THE Oxted tunnel between Woldingham and Oxted, on the London, Brighton and South-Coast Railway, failed a few weeks ago. It has now been repaired and was re-opened for passenger traffic on Sunday last.

THE annual report of the National Union of Railwaymen shows that the number of branches has increased during the year from 1240 to 1270; that the membership, inclusive of those at present absent from the country, has risen from 307,305 to 340,511, and the year's income—£264,180—by £13,166.

THE Great Eastern Company has arranged to provide facilities at its stations in East Anglia for the storage of coal required by farm machinery. This will be of great assistance in view of the extended use of steam-driven machinery in connection with the breaking up and cultivation of grass land for food production.

IN the interest of freight car efficiency the Master Car Builders' Association in America has been directed to modify its rules, for the period of the war, so as to make possible the use of any material that is on hand, and so enable cars, being held for repairs, to be put into service without waiting for material from the owning road.

OVERCOME by the heat, a London and North-Western driver, aged 71, fell off the footplate of his engine at Birmingham and was killed. An official of the company said at the inquest that in normal times a man of this age would not be acting as a driver, but, owing to the war, they had many men over 70 years of age working local trains.

IT is pointed out in the twenty-eighth annual report of the Railway and Canal Commission that the trials of many cases pending in that Court stand over, by consent, until after the termination of the war. The two appointed members of the Court have been actively engaged in other public work arising out of the war which have necessitated continuous work during the year.

THE Pennsylvania Railroad Company has withdrawn 102 trains from its lines east of Pittsburg, which will save 6500 passenger train miles per day. Extensive changes of the same character have been made in the trains west of Pittsburg. The New York Central, in the State of New York alone, has withdrawn 90 passenger trains, and thereby reduced the passenger train mileage by 5 per cent.

ON some railways considerable inconvenience is being experienced by enginemen and goods guards, when having unexpectedly to lodge away from their homes, finding food and lodgings. Mr. J. H. Thomas raised the question in the House last week, and the representative of the Board of Trade said that the President sympathised with the men, and he was taking the matter up with the Railway Executive Committee to see whether some remedy could not be found.

THERE has, for some time, been a controversy between the Louisville and Nashville Railroad and the Western Union Telegraph Company as to the rights of the latter to have telegraph poles along the railway. The United States Secretary of War has now dispatched a message to the heads of the two companies intimating that they would be expected to come to a peaceful and prompt settlement, otherwise the telegraph line would be taken over and operated by the Government in such a way as to make interference impossible.

REPLYING recently to Mr. Wilkie in the House of Commons, Sir A. Stanley said that the Mayors of all the principal towns in Great Britain had received a letter from the Contoller of Coal Mines, asking them to organise a local committee for the distribution of coal during the coming winter. The suggested constitution of such a committee was as follows:—The Mayor or Deputy, the Chief Constable, two coal merchants, one representative of each railway, one representative of each canal, and a secretary. The railway and canal representatives were to act in an advisory capacity only. A letter suggesting labour representation was sent to each Mayor or Deputy at a subsequent date.

ON July 18th the Chief Secretary for Ireland told a deputation that the possibilities of railways for the Castlecomer Collieries had engaged his attention for some time. The departments concerned were satisfied as to these possibilities. He admired the pluck and enterprise shown by Mr. Prior-Wandesforde in developing the collieries, but there was at present a stringency in the matter of materials, labour, and finance. A railway was required for the colliery at Wolfhill, and it would be difficult for the Government to construct two railways at once, but he proposed to put practical reports of the matter before the Controller of Coal Mines. The President of the Board of Trade, Mr. Duke added, had shown personal interest in the question.

THE South-Eastern and Chatham Railway Companies' Managing Committee has intimated that it is again impossible, under existing circumstances, to give any actual figures for publication in respect of the net revenue of the committee divisible between the South-Eastern and London, Chatham and Dover Companies for the half-year ending June 30th last, but that its estimate of the latter company's approximate share of the net revenue is such as enables the directors, with the addition of the company's own separate revenue, and after making provision for prior charges, to announce an interim dividend for the first half of the year 1917, of £2 per cent.—that is, at the rate of £4 per cent. per annum—on the arbitration preference stock of the company.

THE directors of the Taff Vale Railway Company, at a meeting at Cardiff last week, received with regret the resignation of their general manager (Mr. A. Beasley), who has been with the company for twenty-six years. Mr. Beasley was elected to fill the vacancy on the Board of Directors caused by the death of Sir Joseph Weston-Stevens, and he was made deputy chairman. The resignation of Mr. T. E. Harland, superintendent of the line, was also received, and takes effect at the end of this month. He has been associated with the company for a quarter of a century. It will be recollected that Mr. E. A. Prosser, the general manager of the Rhymney Railway Company and the Cardiff Railway Company, was recently appointed general manager of the Taff Vale Company.

NOTES AND MEMORANDA.

ACCORDING to an article in the American Press, yeast is now being used in Germany for the manufacture of buttons, door-bell plates, knife handles, &c.

THE quantity of petrol imported into this country from all sources during the first five months of this year is reported to be 57,036,000 gallons, as against 49,658,000 gallons during the corresponding period of last year.

THE first length of "continuously loaded" paper-core cable in the United Kingdom has recently been laid at Tern Hill, Shropshire, where it became necessary to place underground an important trunk telephone line for a distance of about 1400 yards.

ACCORDING to the *Commercial Motor* there are now 350 flexible gas-holders fitted to commercial vehicles in this country, representing a displacement of petrol at the rate of 700,000 gallons per annum. On an average 250 cubic feet of coal gas is equivalent to 1 gallon of petrol.

A USEFUL cement for fastening metal parts to marble, as in the case of an electrical switchboard, is given in the *American Machinist*. It consists of plaster of Paris, thirty parts; iron filings, ten parts; sal-ammoniac, ½ part. These ingredients, after being mixed, have acetic acid added to make a thin paste, which must be used immediately after mixing.

ONE of the most successful American producers of large shells for the Allies turned out 570,000 9.2 shells between March 1916-17. The largest daily output was 4089. The total number of machines required for the manufacturing operations on the shell body was 403, and on the adapter 116. The number of hands employed was 5565, of which 1748 only were producers, or less than one-third. Over 1000 men were engaged on transporting the shells about the works, and the gauge and tool makers numbered 776, while the inspectors numbered 456.

A RECENT issue of *Metallurgical and Chemical Engineering* contains some notes on the use of magnetic separators in treating minerals in a fine state of division. Thus, in treating monazite sand, magnetite is removed by the weakest magnet, ilmenite by the intermediate, and monazite by the strongest magnet. The use of a series of magnets of different strengths enables discrimination to be made between substances of varying magnetic susceptibility. Magnetic separators of the multipolar type have proved of great utility in purifying some classes of zinc ores, while the magnetic tungsten materials, wolframite, huebnerite, and ferberite appear to lend themselves particularly well to such treatment.

THE production of potash salts in the United States during 1916 has been reported to the amount of 35,739 short tons, having a mean potash content of about 27 per cent. K_2O and a total potash content of 9720 short tons of K_2O. This is almost exactly ten times the production reported for 1915, although it is still perhaps less than 5 per cent. of the normal potash consumption. The largest output, according to the *Chemical Trades Journal*, has come from the alkali lakes in Western Nebraska, which have afforded the most readily available supply of moderately high-grade potash salts, obtained by direct drying of the raw material, with perhaps as few technical complications as could be involved in any chemical operation.

BORACIC acid, it has been found, prevents the formation of slag in arc lamps more effectively than borates or other salts of alkalis, and also makes the light of the arc steadier. The advantage of boracic acid is found to be particularly great in open-arc lamps, whereas in enclosed-arc lamps the resulting advantage is less marked, says the *Electrical World*. It has, moreover, been found that the beneficial action occurs only when the amount of the admixture exceeds a certain limit, depending on the percentage of salt in the positive electrode. The correct proportion must be found experimentally in each case. For example, when positive carbons are used containing about 30 to 40 per cent. of luminous salts, it has been found that about 3 to 5 per cent. of ordinary boracic acid is required, according to the nature of the luminous salts in each case, or a correspondingly smaller quantity when the anhydrite is employed.

THE manufacture of acetone with a view to the production of synthetic rubber is of considerable importance in Germany at present. The importance of this new industry is indicated by the fact that some of the largest firms in Germany have been occupied with this problem for some years. There are firms in Germany producing 10 to 50 tons of carbide per day in order to convert the acetylene into acetic acid and acetone, the latter being intended chiefly for the production of synthetic rubber. This new industry should be of special interest to Switzerland, according to a communication from the Swiss Acetylene Association, since the necessary carbide will in the future be available in large quantities in that country. After the war the export of carbide will be considerably reduced, and this product will therefore become much cheaper. On the other hand, the price of rubber will remain high for several years.

STANDARD bridge designs for Ontario have been prepared by the Provincial Highways Department as suggestions to counties and townships of what meets the Government requirements. The plans are drawn for spans varying by 2ft. up to 90ft. Above that the spans are 100ft. and 120ft. The loading is in all cases known as class "A," which provides for a 15-ton road roller. A bridge of this type is suitable for main travelled or county roads, and is recommended as the standard on all roads. The types of bridges indicated in the standard plans are rolled beams for spans up to 40ft., pony Warren truss for spans of from 40ft. to 90ft., and the through Pratt truss for the longer spans from 100ft. to 120ft. These designs are prepared in accordance with the 1917 specifications for steel highway bridges as issued by the department. According to the *Contract Record*, all the bridges are designed to carry a dead load composed of the weight of the bridge and of a concrete floor 6½in. in thickness in the centre and 5½in. in thickness at the sides, and a live load composed of a 15-ton road roller. End floor beams are recommended for all truss bridges. Similar standard designs are being prepared for concrete bridges.

MISCELLANEA.

THE number of motor cars registered in Calcutta in the twelve months ended March 31st, 1917, was 423, of motor cycles 151, taxi-cabs 287, and lorries 23, and a single omnibus.

IT is stated in a recent issue of an Italian newspaper that from boring operations made last year in the Province of Novara, the existence of an important seam of coal has been ascertained.

A SERIOUS endeavour is about to be made with the aid of the Government to bring into use again a number of old lead mines in Flintshire. This will necessitate the employment of a considerable amount of pumping plant for unwatering purposes.

AT a recent meeting of the Housing and Town Planning Committee of the Birmingham City Council, it was stated that the shortage of houses in this city was between ten and twenty thousand, while at least 50,000 houses in the old parts of the town would have to be replaced.

CERTAIN developments are now taking place in the British magneto industry, which will result in the home manufacturers producing new types of magnetos that will prove vastly superior to anything turned out of Germany in the past, says Mr. A. P. Young, in the *Automobile Engineer*.

PLANTERS in Jamaica are considering a revision of their major industry, banana cultivation, in favour of sugar. Sugar cane is considered to be the best rotation crop for bananas on these lands. A project for a sugar factory for St. Catherine has been considered for some years, and the present time seems favourable for its fruition.

THE completion of the New York State barge canal has been delayed by lawsuits brought by the railroads over the cost of eighty-six bridges. This matter has now been settled, and it is safe to say that this year the canal will be opened from Lake Ontario to the Hudson, and to Buffalo next season, only 7 per cent. of the work remaining to be done. According to an American writer, the canal starts from the world's greatest port, and leads to the world's greatest fresh water artery and to the world's canal of greatest tonnage, the "Soo" Canal.

IN a report on proposals to install hydro-electric power plants in the North Island of New Zealand, Mr. Evan Parry, chief electrical engineer to the Public Works Department of the Dominion, says the scheme of development recommended is that three sources of water-power should be developed in the first place, namely, Lake Waikaremoana for the Hawke's Bay district; Arapuni Gorge (about eight miles from Horahora), or some other place to be selected, for the Auckland district; and the Mangahao River for the Wellington district. These three sources in a natural course of extension will be linked up, thereby enhancing the value of each source by adding to the security of supply and enabling a continuous output to be maintained throughout the whole of the North Island.

THE Committee of the Privy Council for Scientific and Industrial Research, on the recommendation of their Advisory Council, and at the request of the Home-office, have sanctioned the appointment of a Committee to inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations, and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardised, and to collect evidence bearing on these points. The Committee consists of Mr. William Walker, Acting Chief Inspector of Mines under the Home-office (chairman); Mr. John Haldane, LL.D., F.R.S., and Mr. H. Briggs, D.Sc., of the Heriot-Watt College; Mr. A. Richardson has been appointed Secretary to the Committee, and Dr. Henry Briggs has been constituted Director of the Inquiry.

THE Home Secretary has given notice that he proposes, in pursuance of the powers conferred on him by the Police, Factories, &c. (Miscellaneous Provisions), Act, 1916, of making orders for securing the welfare of the workers employed in factories or workshops, to make an Order—to take effect from October 1st next—requiring certain arrangements to be made regarding ambulance and first aid at all factories employing twenty-five or more persons which belong to one or other of the following classes—blast-furnaces, copper mills, iron mills, foundries, and metal works. The proposed Order will impose obligations on the occupiers of these works in respect of the provision and maintenance of first aid boxes or cupboards, and, in the case of factories employing 500 or more persons, the provision and maintenance of an ambulance-room and ambulance carriage. Copies of the draft Order—price 1d. each (by post 1½d.)—may be obtained through the usual agents for Government publications.

ON July 25th, at the Savoy Hotel, the annual general meeting of the Automobile Association and Motor Union was held. Mr. W. Joynson-Hicks, the chairman of the Association, who presided, said that with regard to petrol supplies, motorists had been reduced from 16 to 10 gallons per month, and from 10 to no gallons per month, unless they were doing war work. Personally he did not complain. He had given up his car and chauffeur some time back, and had no use for petrol. They all intended to win this war, and were willing to suffer in their private capacities in order that petrol might be used for more important purposes. There was ample petrol in the world, and there would be no shortage when the war was over. The Shell Company had 18,000,000 gallons of petrol stored waiting to come to this country when the war is over, and tankage is available. He therefore hoped that motorists would realise that petrol prices would go down when the war was over. He quoted figures showing that a surplus of 6,000,000 gallons of petrol had been collected by imports during the first five months of this year, as against the corresponding period last year. He thought they were entitled to ask their friends in the Services to do everything possible to avoid waste of petrol. Last year he spoke very strongly on this subject. This year he found that much of the waste then complained of had been stopped.

OLD ATMOSPHERIC ENGINE AT MADELEY MARKET, SHROPSHIRE

(*For description see page* 94)

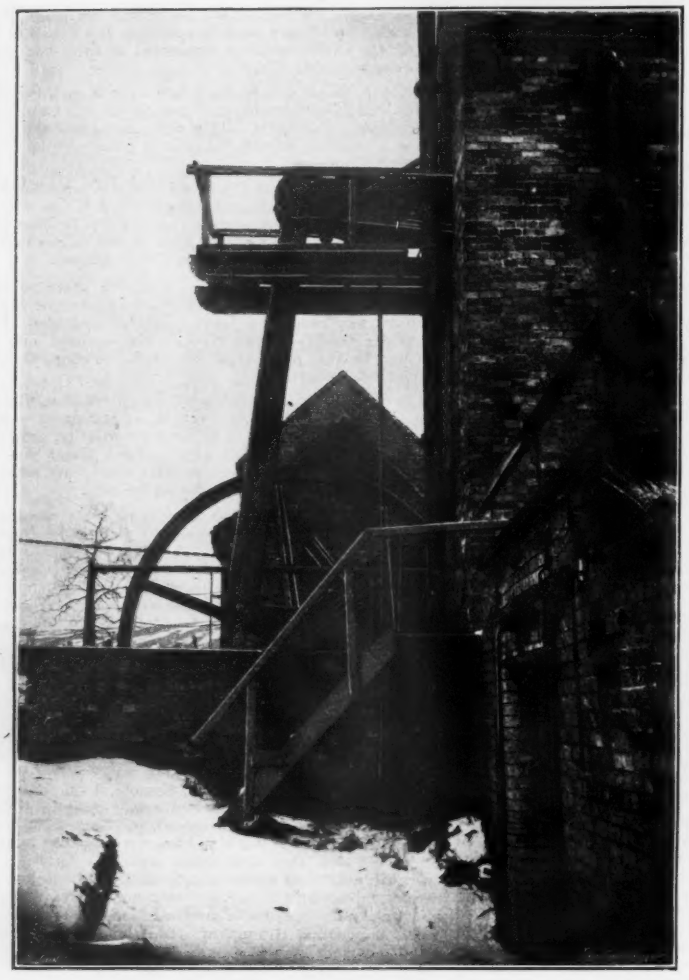


Fig. 6—SIDE VIEW, SHOWING CONNECTING ROD

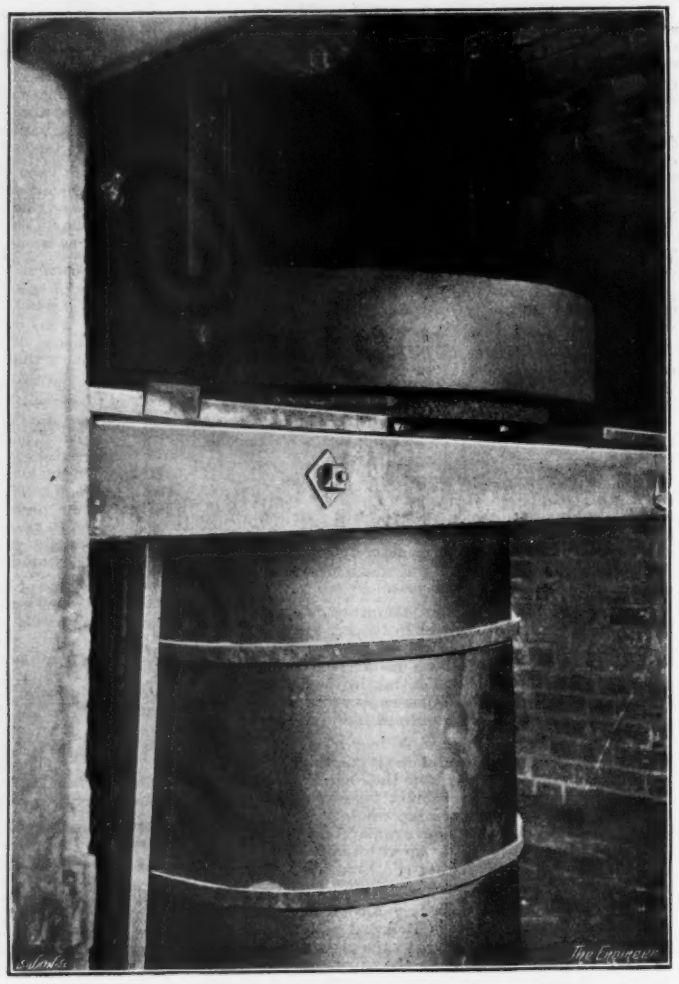


Fig. 7—THE CYLINDER

Fig. 8—THE BEAM FROM ABOVE

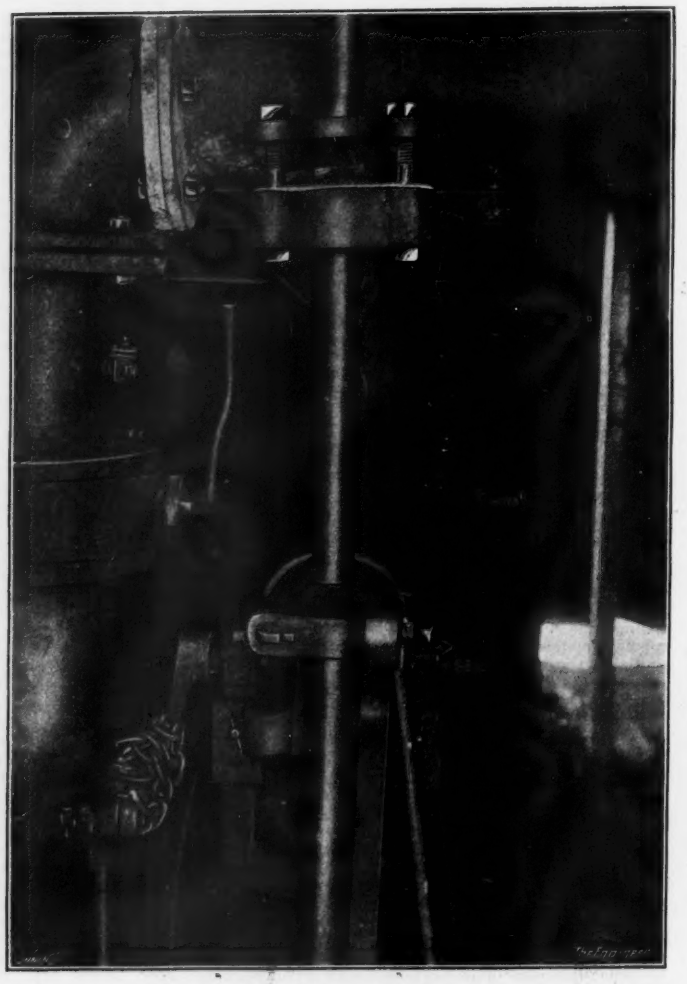


Fig. 9—VALVE MECHANISM

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BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong-Kong.
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Chapelot & Cie., Rue Dauphine, 30, Paris.
INDIA.—A. J. Combridge and Co., Bombay; Thacker and Co., Limited, Bombay.
Thacker, Spink and Co., Calcutta.
ITALY.—Loescher and Co., 307, Corso, Rome; Fratelli Treves, Corso Umberto, I.174, Rome; Fratelli Bocca, Rome; Ulrico Hoepli, Milan; Libreria, Dietken and Rocholl, Naples.
JAPAN.—Kelly and Walsh, Limited, Yokohama.
Maruzen Co., Tokyo and Yokohama.
RUSSIA.—O. Richter, 4, Nevsky Prospect, Petrograd.
AFRICA.—Wm Dawson and Sons, Limited, 7, Son-street (Box 489), Capetown.
Central News Agency, Limited, Johannesburg, Durban, &c., and at all Bookstalls.
Bickers's News Agency, 52, Pritchard-street, Johannesburg; Handel House, Limited, Kloff-street, Johannesburg.
AUSTRALIA.—Gordon and Gotch, Limited, Melbourne, Sydney, Brisbane, Perth, &c.
Melville and Mullen, Melbourne.
Atkinson and Co., Gresham-street, Adelaide.
CANADA.—Dawson, W., and Sons, Limited, Manning-chambers, Toronto.
Gordon and Gotch, Limited, 132, Bay-street, Toronto.
Montreal News Co., 386 and 388, St. James-street, Montreal.
Toronto News Co., 42, Yonge-street, Toronto.
Selle Limited, 368, Shaughnessy-building, McGill-street, Montreal.
CEYLON.—Wijayartna and Co., Colombo.
JAMAICA.—Educational Supply Co., Kingston.
NEW ZEALAND.—Gordon and Gotch, Limited, Wellington and Christchurch; Upton and Co., Auckland; J. Wilson Craig and Co., Napier.
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UNITED STATES OF AMERICA.—International News Co., 83 and 85, Dunne-street, New York; Subscription News Co., Chicago.
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J. Roland Kay Co., Conway Building, Chicago, U.S.A.

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Advertisements cannot be inserted unless delivered before Five o'clock on Thursday evening, and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Monday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

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TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

All letters intended for insertion in The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.

THE LATE MR. ALLISON SMITH.

We are asked by Mrs. Allison Smith if we can help her to trace a photograph of her late husband which, between six and seven years ago, was sent to an advertiser with an application for an appointment. The photograph is the only one in existence, and Mrs. Allison Smith will be very glad indeed to have it back again. We may remind our readers that Mr. Allison Smith was at one time locomotive superintendent of the Victorian Government Railways, and was widely known in Australia and New Zealand. If any reader should find the portrait, and will send it to us, we will forward it to Mrs. Allison Smith.—Ed. The E.

THE ENGINEER.

AUGUST 3, 1917.

The War, Some Metals, and British Industries.

Was it, we wonder, the want of a new Dickens to hold up our failings to ridicule, or a new Reade to lash us with them, that caused our indifference to certain aspects of our national industries before the war? Frankly, we find it hard to explain upon any more reasonable grounds. The British manufacturer is no fool, he knew his business and he produced a good saleable article, and yet he was content that some essential part, from a national point of view, of our business in metals should be controlled by foreigners, and particularly by Germans. Some day, perhaps, someone will make an analysis of the causes which led up step by step to this curious attitude of mind, for it was not a thing of recent growth. When we referred to Dickens in the first line of this article, we had in mind the likeness of the British manufacturer in respect of some of these questions to Podsnap, who, it will be remembered, used to dismiss a subject with a comprehensive sweep of the hand. The thing was impracticable, or wouldn't pay, or else we, and incidentally our grandfathers, had always done it differently, and that was the end of it. Let us, however, quit the abstract and apply ourselves to the concrete.

The position of the copper industry was, before the war, a disgrace to us as a nation. The production of the Empire, no inconsiderable proportion of the total of the world's output, was controlled by a German syndicate worked from New York, but believed to be directed by one of the strongest of the German financial houses. Australia, one of the biggest of the copper producing countries, had no manufacturing industry in that metal, and could not produce a single sheet bar or tube either of copper or brass, and could not make a single cartridge for her own defence. The whole output of raw copper was bought up by the Germans. The greater part of the thick copper tubes, technically known to the trade as "shells," required by English tube makers for drawing down into marketable copper tubes, came from Hamburg, Germany, which produced practically no copper herself, graciously permitting us to use a part of the production of our own Empire. That our manufacturers had a hard struggle to keep afloat against this German and American competition is not to be wondered at, seeing that the raw material was throttled at its source. Their position tended to sap initiative; up-to-date billet piercing machines could not be purchased in this country, because there was no demand for them, and as profits were small or non-existent, renewals of old-fashioned or obsolescent machinery could not be made as they ought to have been. The wonder is that the quality of the goods was maintained under these conditions. Perchance it would not have been had the specifications of the various Government departments, against which, it may be noted, the manufacturer was always kicking, been less stringent. The position of the spelter industry was, if possible, more unsatisfactory. The following figures were given by Mr. O. C. Beale, in an address to the London School of Economics, in February last. Although the ore production of Germany had been steadily declining, the zinc production of that country had increased from 190,000 tons in 1904 to 280,000 tons in 1913. This output depended on Australian ores as the principal source, and was five times the English output. The Germans did all they could to discourage British interest in Australian ore. They fostered, for example, the belief that a suitable clay could not be found in Australia to make the retorts for the distillation of the metal, and it was due alone to the enterprise of a Scottish prospector that a clay, which on trial turned out more refractory than the German specimen, that the German "inexactitude" was exposed. Such stories of our submission to German dogmatism are almost unbelievable, but we know them to be true, although they make us feel as ridiculous as the man in Mark Twain's story, who was imprisoned in a dark and dreary dungeon for forty years, till one day he had a happy idea; he opened the window and got out. Space fails us to enumerate the other metals of which German syndicates were slowly and surely getting the control. The story is much the same in principle, only differing in details, of tin, tungsten, quicksilver, and nickel. When we come to consider the iron and steel industry, the indictment is not, perhaps, so black, but similar conditions were beginning to prevail in that we were relying to a dangerous extent for raw material on German sources of supply. One cause of this was our craze for cheapness, and the Germans' policy of "dumping" on us their surplus production of steel. It has been possible to purchase steel blooms in Germany at a price which, after adding the cost of transport to works in this country, was below the cost of production of the English steel makers, and we have known of other cases where engine builders in this country have purchased German forgings at less than the price of the English blooms which would have been required to make them. It has already been said that a part of this state of affairs is due to "dumping," but another cause is the British engineer's prejudice in favour of steel made by the acid process, which compels the steel maker to import large quantities of comparatively high priced non-phosphoric ore. There is no question that although the German steel works produce large quantities of basic steel which does not come up to our standards—though it is good enough for the purposes intended—they can and do also produce a class of steel which in physical qualities is not a whit behind our best made by the acid process. We know now that attention is being directed to the lower grades of ore available in this country, but with the object lesson in front of us as to what other countries were doing, it should not have required the war to waken our interest in the matter.

These problems will, no doubt, be taken in hand in considering the general question of reconstruction. We say "no doubt" from force of habit, with no very great conviction, for, after all, what is needed is not so much a change of methods as a psychological change—a different manner of judging things and an alteration in our sense of their relative importance. The manufacturer may say with good reason that we never wanted to dominate the world's markets in everything. We utilised our resources and faculties to produce that for which we were most fitted, and were content to leave to others what we could not economically produce ourselves. This would be an excellent principle in a perfect world, but in any scheme of reconstruction we must have in mind more than the somewhat Utopian principle we have enunciated. We must decide what industries are of national importance irrespective of their immediate commercial possibilities, and we must then proceed to organise them so that they shall be at least self-supporting. The man who prides himself on being practical on the strength of continuing to use the methods handed down to him by his great-grandfather will, of course, say that this will mean huge State subsidies in the case of some industries. We do not think so, but we admit that State help may be necessary in some cases for the organisation of particular industries, and some of them need reorganising very much indeed. We can no longer contemplate the possibility of an industry of national importance being carried on in tumble-down buildings, with obsolete machinery and antiquated methods. One can see in the Midlands, we might almost say all over England, scores of cases of small firms, sometimes employing a few hands only, ekeing out a miserable existence under these conditions. We do not suggest that huge combinations are the only remedy; that is going to the other extreme. What we say is that each industry will require a separate treatment, and that between the extremes we have mentioned there exists in every case a happy mean which, with suitable organisation and without State subsidies, will provide proper reward for the labour of the worker and such a share of the world's business as will ensure an adequate return on the capital invested.

Austrian Inland Waterways Project.

Seeing how woeful is the internal condition of Austria, as a perusal of even the censored parliamentary reports and the accounts of the proceedings

of the Viennese City Council sufficiently prove, it may seem surprising that she should be thinking of constructing an extensive system of inland waterways. Nevertheless this is the case, and in June a *Wasserstrassentag*—Inland Waterways Conference—sat for several days in Vienna, when it was resolved to spend large sums and make great sacrifices in order to connect the various Austro-Hungarian rivers by means of a system of navigable canals, and make the rivers themselves navigable wherever they may now be obstructed or too shallow. The main object, however, is to join the Danube and its tributaries with the rivers of Northern Germany, the Elbe, the Oder and the Vistula, and thus connect Austria-Hungary with the Baltic.

The first remark on this project which will be made by everyone even slightly conversant with conditions in the Hapsburg monarchy is: Where can the money be found for the realisation even of plans on a much less grandiose scale than these? Austrian finance is more than £60,000,000—one and a-half billion kronen—on the wrong side, the interest alone on war loans amounted at the end of December last to 1,314,000 kronen, as has been officially admitted in the Austrian Chamber of Deputies; and, now that the sixth war loan is closed, Austria's indebtedness is calculated at 660 kronen per head of population. Even while this very Inland Waterways Conference was sitting and laying such magnicent and extensive plans, a leading Austrian paper was complaining bitterly of the general rottenness in the state of Austria consequent on three years of no Parliament and rigorous censorship, three years during which every ill weed has grown apace. Austria, with her entire population capable of bearing arms at the front, "unable to reckon upon war indemnities paid out of the enemy's pocket"—as one of her deputies recently admitted—with thirty-four billion kronen war debt, and more severely hit than all other countries by the economic results of the war, this Austria would scarcely seem to be the country to embark upon such a project as that adopted by the Inland Waterways Commission. We must, then, look further for the money force. Unquestionably German influence and Germany's plans for improving her own inland waterways and furthering her own trade have much to do with the fact of a people unable to pay their debts, and whose finances are in a state of indescribable confusion, being busy discussing far-reaching internal improvements. Unquestionably it would not be Austria alone who would benefit by Hamburg being connected by water with Vienna, Bulgaria, Roumania, and the Black Sea. Unquestionably, also, the objects which Austria, with Germany behind her, has in view in discussing this vast extension of her inland waterways system and its connection with that of Germany, are not so much commercial as political; they are even very much more political than commercial. Probably also the advantages of a well-developed system of inland waterways have been forced upon the attention of both the Central Empires of late owing to their great and increasing difficulties of transport during the war, difficulties due not only to lack of rolling stock, and lack of men to repair and keep it in order, and to add to it regularly, but to a greater demand for rolling stock, and not least to scarcity of lubricants.

Hence, in spite of the obvious difficulties, the conference decided to proceed to the construction of five new waterways. As to the question of expense, that seems to have been discussed, but in a delightfully vague fashion. One delegate remarked that Austria, despite her heavy financial burdens, should not shrink from expenditure on useful public works, and in the Austrian Parliament a some days later a precisely similar remark was dropped. Such pious utterances, however, create no capital, and where the 761,000,000 kronen are to come from, which the Municipal Architect of Vienna asserted were needed merely for the construction of the Danube-Oder canal and one or two minor pieces of work, is not clear, even although 95,000,000 kronen—about one-eighth—have already been actually obtained. The five contemplated new waterways are as follows:—First, a canal for large vessels, branching off from the Danube at Gänserndorf—on the frontier between Austria and Hungary—and going to Prerau, there dividing into two subsidiary canals, one going North-West to Pardubitz (Bohemia), where it would enter the Elbe, the other going North-East through the Silesian mining and industrial district, to Oderberg, just on the frontier of Silesia and Germany, where it would join the Oder. A third subsidiary canal would branch off at Mährisch-Ostrau (Moravia) in order to form a connection with the Vistula, and thus lead to Cracow. Secondly, another canal would connect the part of the Danube above Vienna with Budweis (Bohemia), and there join the Moldau. If the work is to be adequately performed, however, it will be necessary to canalise not only the Moldau from Budweis to Prague, but also the Elbe between Melnik (Bohemia) and Jaromir. The last named work, so we are assured, is already begun, the river bed being canalised so that ships of 600 tons burden can navigate it. For the Germans will remain the work of regulating the part of the Elbe which runs through Saxony. As for the regularising of the Oder, the Prussian Government has already done a great deal towards this. The Austrians are manifestly specially anxious lest the suspicious outside world should imagine that they are embarking upon this costly and considerable undertaking just now in any way either at the dictation or suggestion of Germany. That all Austrians, whether from financial or political reasons, are not enthusiastic about the project is plain enough, if only from the silent, sullen attitude of some of the representatives of Austrian provincial towns at the Waterways Conference.

It is, of course, possible that this Austrian Inland Waterways Conference may end in mere talk and resolutions, but the way was paved for it by a Danube Conference held in September, 1916, in Budapest, when far-reaching resolutions were passed about making the Danube navigable from Regensburg (Bavaria) to the Iron Gates (Orsova). This conference was attended by 3000 persons, from a number of Austrian, Hungarian, and Bavarian cities and industrial and other associations, all interested in the improvement of Danube navigation, and the development of inland waterways in Germany and Austria-Hungary. It is significant, however, that this earlier conference went the length of passing a resolution emphasising the necessity of having a unified system of private law for navigation on the Danube and the waterways connected therewith, whereby it recommends the closest possible adhesion to the German Inland Waterways Law. Between September, 1916, and June, 1917, the Austrians have had time to reflect a little more upon economic *rapprochement* between their country and Germany, and there is reason to believe that in some quarters at any rate there is not much eagerness for it. With regard to the great Rhine-Danube Inland Waterway, for instance, it is urged sometimes that customs tariffs will form a considerable obstacle. Germany, however, seems to have made up her mind to some increased utilisation of her own and Austro-Hungarian waterways. She now realises that, after the war, she may have much difficulty in pushing her wares, and therefore thinks that it might be well for her to be able to convey them speedily and cheaply to the Balkans and Turkey, receiving in exchange the agricultural products of those countries. A German engineer recently calculated that the freight by inland waterway from Cologne to the centre of the Balkans, a distance of about 1560 miles, would amount to 8.67 marks per ton, or less than 9s., and that it might even be lower in practice. Before the war the freight by sea for this journey amounted to about 14 marks—say, 14s. Hitherto there have been far more boats going up the Danube than going down it; consequently return freights have been difficult to procure, which is one reason why Danube navigation has been comparatively neglected. Were the Danube connected with the Main and the Rhine, however, it is hoped that this would be altered.

Behind all these plans is, undoubtedly, Germany, and German hopes—hopes that English goods may be ousted in Turkey, because with a Rhine-Danube canal it would be so much cheaper to convey German goods thither, and also that in the future war of which Germans are still fond of *talking*, a Rhine-Danube waterway navigable for large vessels would make the Central Empires much more independent of British sea-power. All these considerations appear with the utmost plainness in the debate in the German Reichstag last March, when all speakers, we are told, advocated the construction of the Rhine-Main-Danube canal for large vessels, the cost of which was put at about £32,500,000. Therefore, despite the poverty of Austria and her general disarray and disorganisation, this project is one demanding the serious attention of both engineers and economists, and is no mere extravaganza to smile at and then forget.

WELSH LABOUR.

The first report of the eight Commissions which were appointed on June 12th to investigate labour unrest appeared before the public on Tuesday last. It deals with conditions of Welsh labour and is signed by Mr. D. Lleufer Thomas, Mr. Thomas Evans, Mr. Vernon Hartshorn and Mr. Edgar L. Chappell, the secretary. Under any conditions, it would be a remarkable document, and it is made doubly so by the speed with which it has been prepared. Indeed, reading it one feels that the opinions expressed cannot be the result of the hurried work of a month in which many witnesses had to be heard, and piles of correspondence dealt with, but are, in fact, views that have been long matured in the minds of one or more of the three Commissioners, who have taken this opportunity of presenting them.

The report opens with a review of some of the chief industries in Wales and their distribution, which is based avowedly in part, and we may assume practically as a whole, upon the Industrial Census. It is followed by a section which deals with the physical and geographical characteristics, and their influence on the industries of South Wales, and on social conditions. Here we break into less statistical ground. Coal mining is the only industry considered, for in South Wales "Coal is King." "The public," say the Commissioners, "have been slow to recognise the full significance of this fact; they are far from adequately realising it even yet, but the miners themselves are fully conscious of the supreme position which their industry occupies. So, too, of course, are the coal owners. Both are well informed as to their position, and both are well organised." Coal has an effect upon the conditions of the people which it is perhaps difficult for those who do not live in an environment of it quite to recognise. "A fundamental fact as to this industry in South Wales is that the life of the workers engaged in it is conditioned at every point, and in every form of activity, by the physical and geographical conditions of the district itself. The physical configuration of the coalfield is markedly different from that of any other coal area in Great Britain, and is a factor that profoundly affects and largely conditions the social life of the inhabitants." Owing to this geological configuration, the population is forced to live crowded in narrow valleys and with its houses jostled by the surface works and by-product plants of the collieries. Fine buildings are almost or entirely unknown, and municipal buildings with any pretensions to dignity are extremely rare. The effect upon the mentality of the people is pronounced, for those things which develop "the civic spirit and the sense of social solidarity" are lacking.

The reporters paint a grey picture indeed of the life of the miners. "In several of the valleys," they write, "most of the houses have been built on the less sunny side, often, indeed, in positions where it is impossible for any sunshine to penetrate the houses. A serious burden is thus thrown on the community, owing to the ill-health, and consequent reduction of efficiency, including the greater pre-disposition to fatigue, resulting from living in sunless houses and in dark back rooms giving on to the excavated portions of so many hill sites." Gloomy as these houses are, they are made darker still by the overshadowing of huge coal tips, and are rendered doubly uncomfortable by the difficulties and troubles resulting from frequent subsidences, heavy floods, and occasional landslides. Land suitable for gardens and allotments is extremely rare, and not only are the older folk unable to find any open spaces for recreation, but, worse still, the very children themselves are condemned to play only on asphalted yards, which partake of the general grey dun-ness of the surroundings into which they are born, and in which they will pass their lives—"a state of affairs which is serious in the effects from the moral, social, and public health point of view." Most of us who visit Wales know only its picturesque aspects. We see little or nothing of the great mining population, and have no means of knowing the conditions under which it lives, conditions which advanced thought, since Spencer's time at least, has taught us to regard as one of the most potent factors in the moulding of mind and character. The Commissioners have done well, therefore, in putting in the forefront of their report this picture, and a gloomy picture it is, of the environment of the miners of South Wales.

In their next section they discuss a number of sociological factors:—Race Characteristics—Rapid Increase of Population—Language—and Educational and Political Activities. At one time the populations of the Welsh industrial areas were constant, and there was little immigration, but the development of coal mining, and also to a less extent of steel and tin-plate manufacture and transportation, has led to the influx of many people strange to the districts or strange even to the country. It is most notable that a great number of single young men have entered the industrial life of Wales, a fact, say the Commissioners, which may "to some extent account for the tendency to rash and impulsive action on the part of certain sections of the community." The report lays not a little of the blame for unrest on these immigrants. Some, it tells us, cut off from their old religious and other restraining influences, drift into indifference, whilst others, flushed with success and large earnings, give play to self-indulgence. Others again, moved by socialistic motives, aim "perhaps too exclusively at the merely economic welfare of their own class." Then, too, managers and other officials drawn from other countries, ignorant of the Welsh language, and lacking in sympathy with the genius of the Welsh people, are productive of misunderstanding and friction.

Under the sub-heading Political Education and Trade Unionism the Commissioners deal with a most important subject which it is practically impossible

to summarise briefly. We learn that whilst in the early days the trade union was largely a club without political influence, a change has gradually spread over the spirit of the lodges, and there is now a tendency "more and more to formulate a theory of reform, and of political action which is almost entirely opposed to that of the old." The rights of Labour are, of course, the first thing considered. The lodges "have become centres of *educational* work from which lectures and classes on political and social subjects have been organised, and they have become centres of *social* and *political* activity more potent perhaps than any other of the social movements in the community." The most advanced men hold views which we gather from the description are those of the syndicalist, for "believing that the final and root causes of the conflict between employer and employee lie in the relation between Capital and Labour, they see in the strengthening of the union a means of forging a firmly welded weapon which will ultimately be sufficiently powerful to overcome and reorganise the capitalistic forces ranged against them. . . . Political government, they maintain, will have no effect when faced by industrial unionism in the control of production." But these advanced opinions have been continually checked by the lack of education of the great mass of Welsh labour, and in order to complete their organisation the two great unions, the South Wales Miners' Federation and the National Union of Railwaymen, have assumed responsibility for a central labour college in which economics, industrial history, and the modern working-class movement are taught "free from the bias and prejudice of the upper class conception of history and economics." There has thus arisen in Wales an "increasing weight of powerful determined opinion against which the employers are helpless." But so, within their sphere, are the workers, and between the two a great gulf is fixed. It is hoped that in some measure it may be bridged by a wider and a better education, and a joint scheme of lectures under which an expert appointed by employers and employed will explain the true economics of certain industries, is looked forward to with some anticipations that it may undermine the present misunderstanding.

Up to this point the report is devoted to the creation of an atmosphere. Its object has been to show the conditions of industrial life in Wales, so that the value of the reforms suggested may be more fully appreciated. In some sense it is an apology for the restlessness of the Welsh worker, for it exhibits the conditions both natural and social that have encouraged the spirit of unrest. It now passes on to consider the unrest itself. It first advances reasons why unrest displays itself more frequently amongst the colliers than amongst other Welsh workers, and then touches upon other industries. It points out that whilst many disputes would appear to have but a trivial origin they, as a matter of fact, but mark the culminating point of growing dissatisfaction, and it emphasises the view that "most of the disputes that have taken place during recent years in the South Wales coalfield could and would have been avoided if both sides had approached one another in a conciliatory spirit." It is the strong conviction of the Commissioners that "the first step towards industrial peace lies in a change of disposition on the part of both employers and men"—a very safe conviction which no one is in the least likely to challenge.

The causes of unrest are discussed under two headings, the Permanent Causes and the Temporary, or as we may call them the War Causes. They cover a great variety of subjects, and it would take too long to detail them all, and would interest very few of our readers. Moreover, it cannot be said that the Commissioners have discovered a single cause that was unknown before, though they have unquestionably done useful work in putting known causes forward in a definite form. But whilst we shall not detail the causes we must glance at some of the Recommendations for removing them, and in so doing we shall indicate the nature of the causes themselves. The Commissioners found their proposals on the two principles that—

(*a*) The present system should be modified in such a way as to identify the worker more closely with the control of the industry in which he is engaged.

(*b*) Every employee should be guaranteed what we may call "security of tenure"—that is, that no workman should be liable to be dismissed except with the consent of his fellow-workers as well as his employer.

For the realisation of these principles certain machinery already exists. In the first place there are the trade unions and employers' organisations. The Commissioners urge that all men should be obliged to join a union and that there should be one union for each industry. On the other hand, employers must join an organisation or accept the rulings and agreements of organisations representing their industries. Then there are the conciliation boards in which the Commissioners have much faith, but we observe with pleasure that they are not in favour of compulsory arbitration. Industrial Councils come next. Under this heading approval of the Whitley scheme is expressed. "We are of opinion that the machinery of the proposed three-fold Councils—Works Committees, District Councils, National Councils—would provide the means for the developing of the policy we have already advocated of identifying the worker more closely with the control of his particular industry. We therefore gladly adopt the main principles underlying the whole of the Report, and believe that the adaptation and extension of the existing machinery in the coal-mining and metal industries on the lines therein recommended would be likely to contribute very substantially to improved relations." The next recommendation deals with the Enforcement of Agreements. Employers had asked the Commissioners to advise that the trades union funds should be made liable for injury done by an irregular strike. This they refuse to do, believing that if the unions are made sufficiently powerful and sufficiently representative of the industries, strikes without their sanction will be rare indeed. The Equalisation of Wages is then considered, then the Decasualisation of Labour, a Shorter Working Day, Improved Conditions of Work, Improvement of Housing Conditions, Better Educational Facilities, the Restoration of Pre-war Conditions, and a number of other factors. Our readers have already been made familiar with the general nature of these various recommendations by the summarised report, written by Mr. George N. Barnes, which appeared in the general Press a few days ago, and it would be mere repetition to give abstracts of them here.

Looking at the Report as a whole, we find ourselves, as perhaps we ought to be, left with no very definite impression that the Commissioners think the faults lie more on one side than on the other, but at the same time it is impossible not to feel that the recommendations without exception are a tacit acceptance of the case for Labour, and that the aspect as seen from the employers' standpoint receives relatively little consideration. We poirt this out, but we are far from saying it is not right. The Commissioners were appointed to consider Labour Unrest, and it is to Labour that they give most attention. The day may come when similar Commissions will have to inquire into Capital Unrest—a matter at least as important to the welfare of the country.

LITERATURE.

SHORT NOTICES.

Industrial and Manufacturing Chemistry. Part II.: Inorganic. Volume II. By Geoffrey Martin, Ph.D., D.Sc. London: Crosby Lockwood and Son. Price 25s. net.—We have already reviewed the first volume of this second part of Dr. Martin's treatise on industrial chemistry. As in the two previous volumes, Dr. Martin himself contributes several of the chapters, the remainder being supplied by certain other authorities. Of the thirty-eight sections in the present volume, nine are exact reprints of the chapters contained in the second volume of the "Manuals of Chemical Technology," published, in 1915, by Messrs. Crosby Lockwood, under Dr. Martin's editorship. These nine sections deal with the rare earth industry. The remaining sections cover a wide variety of miscellaneous industries, the chief being those devoted to disinfectants and antiseptics, artificial manures, cement, and glass. The book, like its companions, will undoubtedly prove of great value not only to chemists, but to many engineers. Once again, however, we have to complain, not of the matter which it contains, but of the manner in which that matter is presented. The average quality of the illustrations is poor, and misprints are not rare. In most cases, however, the misprints are easily detected, as, for example, that on page 63, where "albuminates" is printed for "aluminates."

Mechanical Handling of Material, and its National Importance during and after the War. By G. F. Zimmer. London: Crosby Lockwood and Son. Price 10s. 6d. net.—The author of this book is such a well-known writer on the mechanical handling of material that it is hardly necessary for us to recommend it to the attention of those interested in this important subject. Its main object is to describe certain recent improvements and developments in the machinery for, and methods of, handling material. Its *motif* is found in the present circumstances, and those likely to prevail immediately after the war. The necessity which the scarcity of labour imposes, and will continue to impose on us, of doing as much as possible by mechanical means is, or should be, recognised to-day by all engineers. In no field probably is there a bigger opportunity for thus economising human labour than that of handling material. Mr. Zimmer's book, with its numerous illustrations, is a very valuable guide to what has already been done in this direction, and taken in conjunction with his previous larger work on the same subject, is full of assistance as to the possibilities and relative advantages of various alternative methods of handling material mechanically.

The Properties of Aerofoils and Aerodynamic Bodies. By A. W. Judge, A.R.C.Sc. London: Whittaker and Co. Price 15s. net.—This book forms the second of four volumes on aeronautics, of which the first, the "Design of Aeroplanes," also by Mr. Judge, was published over a year ago. The succeeding volumes are to deal with the stability and control of aeroplanes, and with aeronautical materials and methods of construction. The present volume gives in convenient form the results of all the most important experiments which have been made as to the lift and resistance of aeroplane wings, the head resistance of airship envelopes, aeroplane fuselages, &c., the skin friction of aerodynamical bodies, and so on. The author has drawn largely upon the reports of M. Eiffel, and the National Physical Laboratory, as, of course, he was almost bound to do. Many of the diagrams, and much of the matter, will thus already be familiar to aeronautical readers. The chief value of the book undoubtedly lies in the collection and co-ordination of the various experimental results.

Steel and its Heat Treatment. By D. K. Bullens. New York: John Wiley and Sons. London: Chapman and Hall, Limited.—This volume appears to us to present a satisfactory account of the annealing, hardening, tempering, toughening, and case carburising of steel. It deals largely, if not wholly, with the heat treatment of steel from the American point of view. Its general tendency is thoroughly practical, but there is sufficient space devoted to the more scientific side of its subject to enable the reader to grasp the principal theoretical features so far discovered regarding the heat treatment of steel It deals at some length with the construction and working of heat treatment furnaces, and discusses in separate chapters the detailed treatment of such special steels as nickel, chrome, chrome-nickel, and vanadium steels. In an appendix of no great length the heat treatment of high-speed steel is discussed.

Naval Architecture. By J. E. Steele, B.Sc. Cambridge University Press. Price 5s. net.—This small book should be of great assistance, not only to those students for whom it is primarily intended, but to all those who desire an introduction to the mysteries of naval architecture and shipyard work. It is, of course, an elementary work, but as an introduction to its subject it is one of the best we have seen. The first six chapters are descriptive of the manner of construction of a ship's hull and how it is put together. The two remaining chapters are devoted to calculations and the exposition of certain fundamental theoretical matters connected with naval architecture. Mr. Steele writes concisely, yet clearly. The illustrations are numerous and good. We can cordially recommend the book.

Saws: Their Care and Treatment. By the late H. W. Durham. London: William Rider and Son, Limited, 8, Paternoster-row, E.C. Price 5s. net.—Although this book deals primarily with wood-working saws, the information in it should be of great service to all concerned with the construction, running, and upkeep of saws of all descriptions. It is filled with a great quantity of practical information acquired by the author during his lengthy study of the branch of engineering in which he specialised. It is clearly written and well illustrated.

BOOKS RECEIVED.

The Trade of To-morrow. By Ernest J. P. Benn. London: Jarrold and Sons. 1917. Price 2s. 6d. net.

Design of Railway Location. By Clement C. Williams. London: Chapman and Hall. 1917. Price 16s. 6s. net.

Correction Tables for Thermodynamic Efficiency. By C. H. Naylor. London: Edward Arnold. 1917. Price 5s. net.

Scientific Treatise on Smoke Abatement. By H. Hamilton. Sherratt and Hughes, 34, Cross-street, Manchester. 1917. 5s. net.

City and Guilds of London Institute—Department of Technology. Programme for the Session 1917-18. London: John Murray. Price 9d. net.

Heat Drop Tables—Absolute Pressures. By Herbert Moss and Professor H. L. Callendar, F.R.S. London: Edward Arnold. 1917. Price 5s. net.

Cours de Géometrie Pure et Appliquée de l'école Polytechnique. By Maurice D'Ocagne. Tome I. Paris: Gauthier-Villars et Cie, 1917. Price 16 francs.

Concrete—Plain and Reinforced. By Dr. Frederick W. Taylor and Sanford E. Thompson. Third Edition. London: Chapman and Hall. 1916. Price 23s. net.

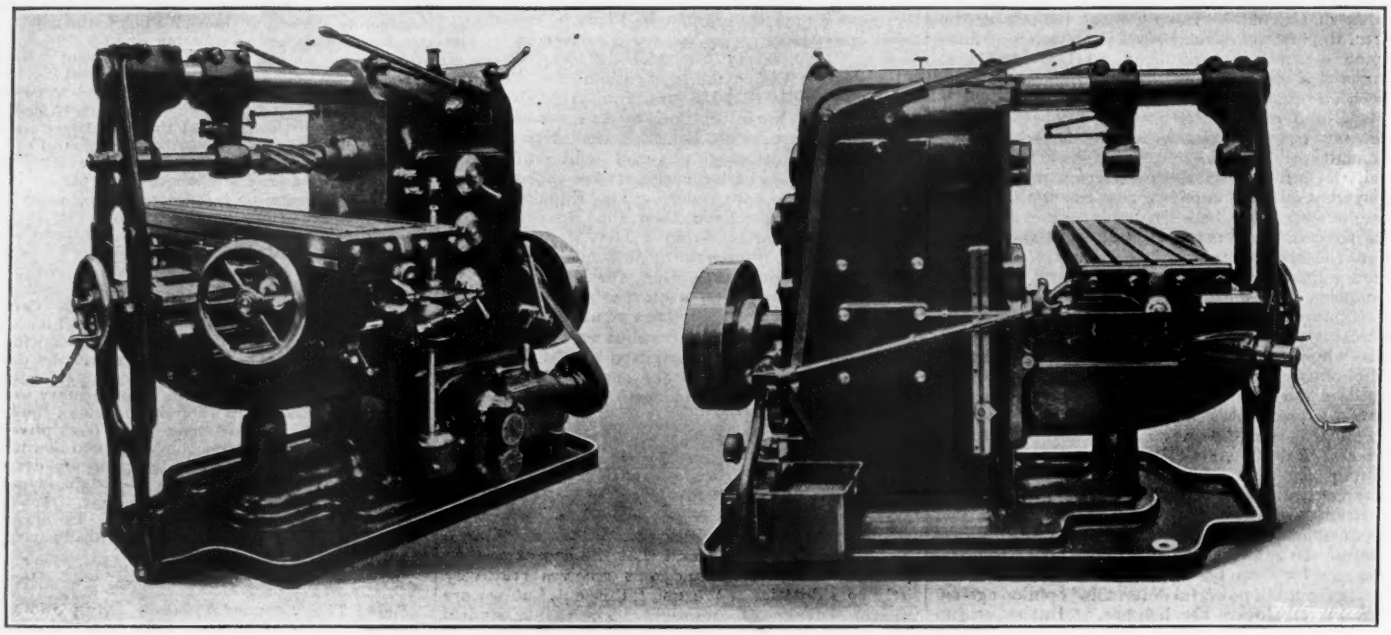
"*Magnetic and other Properties of Iron–Aluminium Alloys Melted in Vacuo.*" By Trygve D. Yeusen and Walter A. Gatward. University of Illinois Bulletin No. 95. January 29th, 1917. Price seventy cents. European Agent: Chapman and Hall, Limited.

NAVAL DRY DOCK.

The new dry dock for the Navy Department at Norfolk, U.S.A., will be 1000ft. long, 110ft. deep, and with 43½ft. of water on the sills. The sills are 2ft. above the floor. The blocks along the floor of the dock are 5½ft. high, spaced 2ft. apart. Besides the two seats for the caisson to close the entrance, seats are provided for an intermediate caisson, so that smaller vessels can be handled in one section of the dock, thus saving time in emptying and filling the dock. This intermediate caisson divides the dock into two sections 650ft. and 350ft. long. The only present vessels larger than 650ft. are the battle-cruisers, so that most of the large ships can be handled in the longer portion of the dock, while the other portion can be used for smaller craft. All caissons are alike and have no valves for flooding the dock. Their only equipment is for flooding and pumping out the caisson itself. This is electrically operated, and can pump out the water in 15 minutes. The pumping plant for the dock is in separate units to prevent complete disablement. The dock can be flooded in 30 minutes by means of numerous openings with hydraulically-operated quick-acting valves. It can be pumped out in 1½ hours when no vessel is in the dock. There are only three altars, 3ft. wide, one at an elevation of 1ft. above high-water, and the others at 18ft. and 24ft. above the keel blocks. This reduces the top width of the dock. There are three sets of stairs on each side, but no chutes or slides for timber are provided, owing to the steepness of the sides. A high-speed hydraulic lift will carry passengers and light goods. Around the dock will travel a 50-ton electric crane, running on three lines of standard gauge, and having a horizontal jib reaching far enough to serve the floor of the dock. There will also be electric capstans to handle two lines, and the use of electric towing locomotives—as at the Panama Canal—has been proposed.

42-INCH PLAIN HORIZONTAL MILLING MACHINE

SMITH AND COVENTRY, LIMITED, MANCHESTER, ENGINEERS



42-INCH PLAIN HORIZONTAL MILLING MACHINE.

A series of heavy plain milling machines is now being built by Smith and Coventry, Limited, Manchester, and the machines are illustrated in the accompanying engravings. Although as will be seen, in general design the tool is not a new departure, it embodies several special features, and is built of exceptional rigidity to withstand the increased stresses imposed by modern milling operations. For instance, the column is of very liberal dimensions, and it will be noted that the whole machine stands in a pan base to which the brace casting is bolted, so that when locked to the knee a triple brace of great rigidity is formed—compared with that obtained with the usual brace from the overarm to the knee only. The openings in the column are few and as small as possible consistent with ready accessibility of the mechanism contained. The vertical slide face is of considerable width, and is carried well above the spindle centre so as to give a large area for bolting on the various attachments frequently required in milling operations. The knee is of box section with inside strengthening ribs, and has a long bearing on the vertical slide to which it can be securely clamped by means of two lock handles. The screw for elevating the knee is made of the telescopic type, so as to obviate the necessity of cutting a hole in the foundation. This screw and the work-table screw are provided with ball bearings. The cross slide has a narrow guide formed by one of the faces of the knee bracket, and is of such a length as to give support to the work table in all positions.

The table has three slots for ¾in. bolts. Wide channels are provided to lead the cutting coolant to the tank shown on the left-hand side of the machine. This liquid is conveyed by means of a telescopic metal tube, which can be easily removed when not required. The spindle is of forged steel with a hole drilled throughout its entire length, and a B. and S. taper hole in the front end. The bearings are large, that in the front being tapered and the back one parallel with concentric adjustment. The spindle nose is designed for powerful driving, and large face mills are centred on the outer diameter of the nose. These are attached to the face by screws, and a large thrust washer is provided behind the nose.

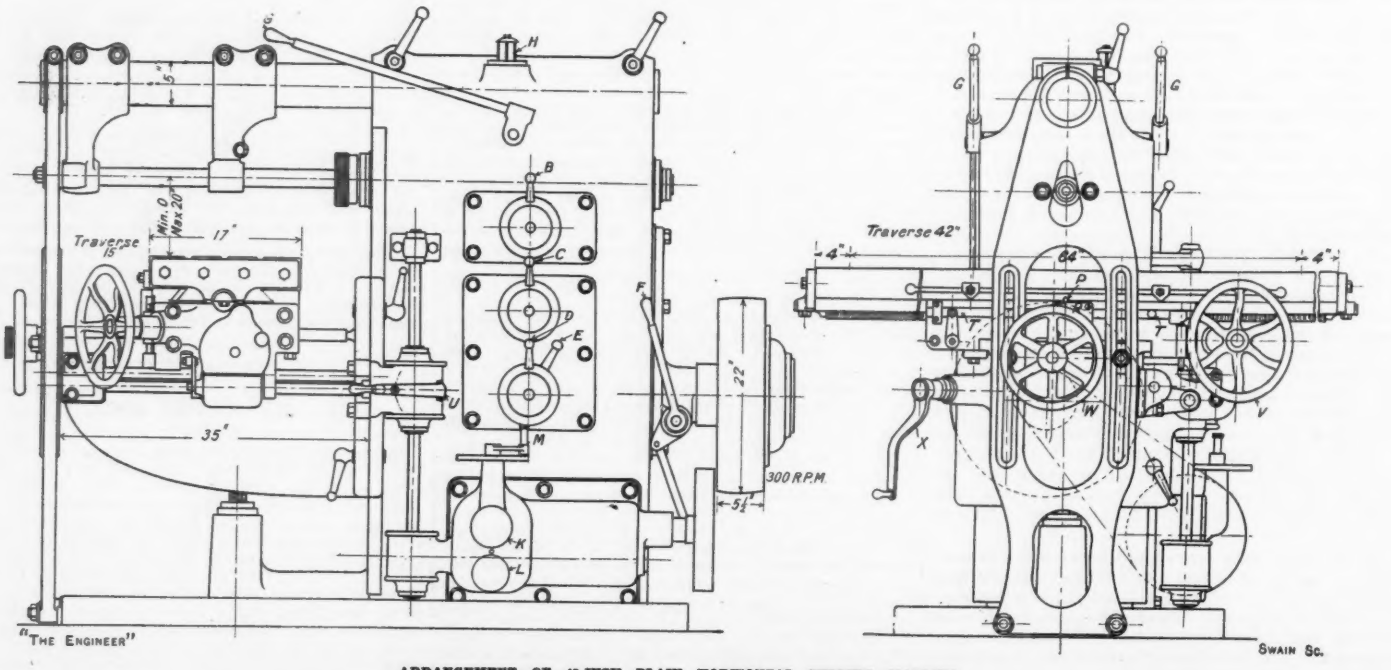
There are sixteen spindle speeds, obtained by sliding gears from a constant speed pulley 22in. diameter, and 5in. belt. The pulley contains a metal-to-metal friction clutch, by which motion is transmitted to the gearing.

The gear wheels are provided with interlocking devices, and all changes of speed are readily obtained by means of the face levers marked B, C, D, E, shown on one side of the machine. A speed table is attached to show the operator at a glance the different positions for the levers, letters being fixed on the machine to correspond with the speed table. The machine can be started and stopped instantly by means of hand levers arranged on either side.

Referring to the general arrangement drawings F, is the clutch lever for inching, G the clutch lever for operator's control, H is a sight glass for oil lubrication, K and L the feed change dials, M the feed change handle, P the table feed trip plunger, R the trip lever box, T the feed trip knobs, U the feed reverse lever, V the table traverse hand wheel, W the cross traverse hand wheel, and X the vertical traverse crank.

Heat-treated alloy steel of high tensile quality is used in the manufacture of the gear wheels for the spindle drive, and an efficient system of lubrication is provided inside the gear chamber. The oil is forced up into a trough fixed in the upper part of the body by a plunger pump, and is then distributed to the various bearings by means of piping, wick, &c. The feeds are sixteen in number, ranging from ½in. to 20in. per minute; they are independent of the spindle speeds, being driven from a constant speed pulley, and instantly stopped and started by the same levers that control the spindle drive. The arrangement of the feed box is the subject of British and foreign patents.

The machine is made in three sizes, for 30in., 36in., and 42in traverse, complete with self-acting trip and hand motions to the longitudinal, transverse, and vertical feeds. The vertical traverse of the 42in. machine is 19in., the cross traverse 15in., and the working surface of the table 17in. by 64in.; the overhanging arm is 5in. diameter. The net weight of the 42in. machine is 80 cwt.



ARRANGEMENT OF 42-INCH PLAIN HORIZONTAL MILLING MACHINE

THE LOSS OF H.M.S. ARIADNE.

The protected cruiser Ariadne, whose loss by submarine attack has just been announced, belonged to the group of eight ships known as the "Diadem" class. She was laid down at Clydebank in 1896, and completed four years later, the principal dimensions being:—Length over all, 462½ft.; beam, 69ft.; draught, 27¼ft.; displacement, 11,000 tons. The machinery installation consisted of two sets of four-cylinder vertical inverted triple-expansion engines, driving twin screws, and supplied with steam by thirty Belleville boilers. On an eight-hour full power trial the engines developed a mean of 19,156 horse-power, giving a speed of 21.50 knots. The normal coal supply was 1000 tons, which could be increased to 2000 tons, plus 400 tons of oil. All the units of this class were excellent steamers. In 1903 the Spartiate and Europa made a cruise to China and back, followed by manœuvres, the total distance covered being about 25,000 miles. The Europa accomplished this without revealing a single defect in the engine-room, while the Spartiate had only to report a split condenser. In both ships 75 per cent. of the stokers were "raw."

In other respects, however, the class was not so satisfactory. They had no side armour, and the 4in. protective deck, which weighed 1500 tons, could not be considered an effective defence to the vital parts. In view of the great displacement the armament was extraordinarily feeble, comprising only sixteen 6in. quick-firing guns and 24 smaller pieces, with two submerged torpedo tubes. At the time these ships were launched several foreign Powers were completing cruisers of considerably less displacement but far greater fighting value. For instance, the Japanese Asama, of 9750 tons, built at Elswick, carried four 8in. and fourteen 6in. guns; she had a 7in. belt on the water-line, and attained a trial speed of 23 knots. The Chilean cruiser O'Higgins—8500 tons—was armed with four 8in. and ten 6in., and had excellent armour protection, while her speed was 21.5 knots. Beside such vessels as these the Ariadne and her sisters made a very unimpressive showing. Their sole claim to distinction was the large coal capacity, but this seemed a somewhat superfluous feature in the cruisers of a Power so well supplied with coaling stations in every part of the world as Great Britain. It was not until seven or eight years later that the question of gun-power in cruisers received from the Admiralty the attention it merited. Then, however, cruisers were designed, such as the Duke of Edinburgh, and the "Warrior" and "Minotaur" classes, which in point of armament were superior to any afloat. The lost Ariadne belonged to a period when the vital importance of the gun was overlooked by the Admiralty, and armament was ruthlessly sacrificed for other qualities which contributed but little to fighting value. We need only compare the designs of twenty years ago with those of our ships now in service to realise how far we have progressed in the direction of giving every class of vessel the highest possible degree of fighting power, and putting every ton of displacement to the most practical use.

CALIFORNIAN MAGNESITE.

One of the results which the war has had in the United States—a result, be it said, which was arrived at long before the entry into the struggle of that country, is the large development of the Californian magnesite industry. The breaking out of the war in Europe shut off importations of Austrian and Hungarian magnesite, and greatly curtailed shipments from Greece. This forced the American market to use Californian material, and to pay carriage rates, which, in normal times, it could not stand. Among the places directly affected by this demand was Porterville, in California. The American Magnesite Company, in September last, built a plant for calcining crude magnesite mined in the district, with the object of reducing the cost to eastern consumers. The plant, according to a bulletin published by the Standard Oil Company of San Francisco, is calcining about 200 tons of crude magnesite daily, and is producing some 80 tons of calcined material. Oil is used for fuel, about 120 barrels being consumed in the 24 hours. The magnesite burned in this plant is all taken by the American Refractories Company of Chicago, and daily shipments are made to its factories at Harper, Ohio, and at Utica, Ill., where the material is manufactured into blocks for furnace linings or sintered for use in the bottoms of open-hearth steel furnaces.

The first magnesite was imported into the United States from Greece in the early eighties. During 1885 about 500 tons were imported. The yearly total gradually increased until, in 1913, the total was 175,000 tons of calcined product. Up to the year 1914 the production of Californian magnesite had not exceeded 10,000 tons. The monthly output from Porterville alone is considerably in excess of that tonnage.

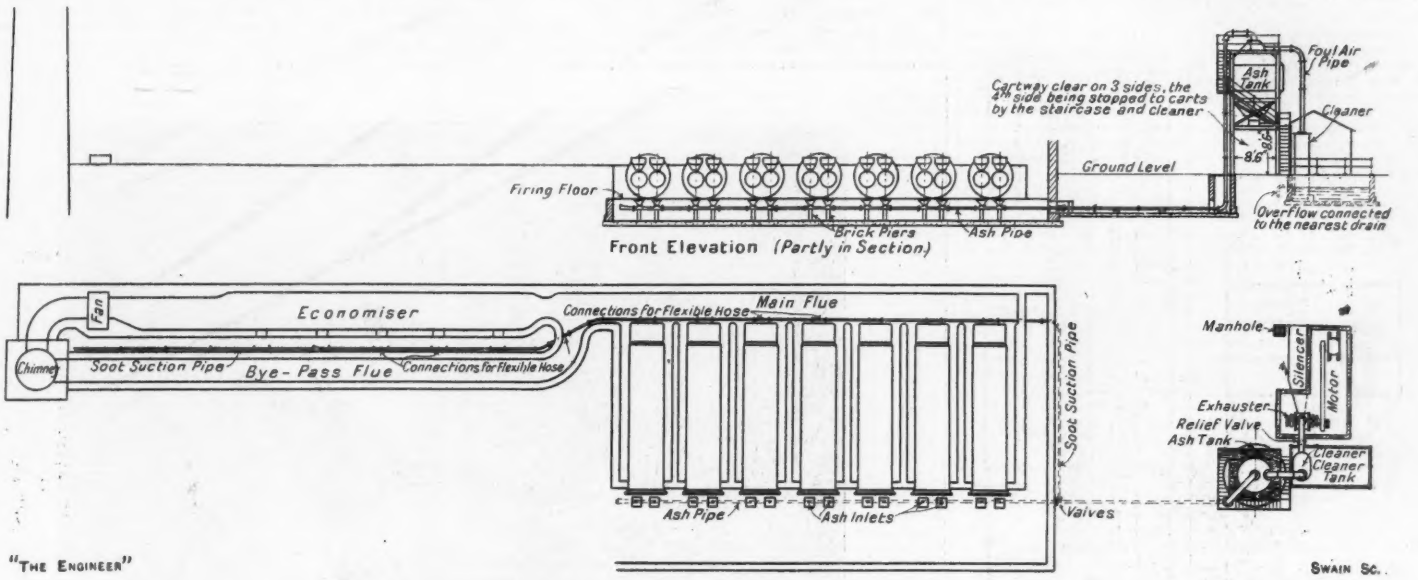


Fig. 1—TYPICAL LAY-OUT OF BENNIS ASH AND SOOT HANDLING PLANT

PNEUMATIC ASH-HANDLING PLANT.

In modern industry the question of the removal of the ashes produced in boiler-houses is of considerable importance, and, at the present time, the problem is even more difficult to solve than it used to be. It is not merely that the trend of progress is in the direction of employing larger and more numerous units per installation, with a consequent increase in the amount ot ash and clinker produced—though this, in itself, has, of course, been sufficient to create a demand for machinery capable of dealing economically and automatically with large quantities of these materials—but the position is nowadays complicated by the limited supply of labour.

Among the most recent methods devised for transporting the ashes from beneath the boilers to points at which they may be loaded into trucks or other vehicles for transportation, is that in which the work is performed pneumatically. This system has been fairly widely employed in the United States, and, though it has been less frequently used in this country, there are a good many instances where it is at work here. One installation, which works on this system, namely, that at the Clifton Junction Power House of the Lancashire and Yorkshire Railway, has already been described in our columns—see The Engineer, January 21st, 1915. That plant was supplied by Babcock and Wilcox, Limited, the exhauster having been made by the Sturtevant Engineering Company, of America. Another firm which has taken up the question of supplying conveying plants of this type is that of Ed. Bennis and Co., Limited, of Little Hulton, which has recently fitted up a number of boiler-houses on this principle, in one of which the number of boilers involved was no less than 32. Briefly described, the plant furnished by this firm comprises a rotary exhauster, driven by motor or in some other manner, foul air cleaner, one or more ash receivers, and the necessary pipe lines. A typical lay-out of one of its installations is shown in Fig. 1. The pipes for ashes are usually laid in front of the boilers, and those for dust and soot are run at the rear of the boilers. In the case of the ash pipes, a hole is provided in the floor plate in the front of each boiler, each hole being filled with a dumping hopper, grid, and an air cut-off. By this means the ashes are dumped direct into the ash pipe as they are drawn from below the furnace. A typical arrangement is illustrated in Fig. 2. The pipes employed for conveying the ashes are of hard cast iron and are furnished with

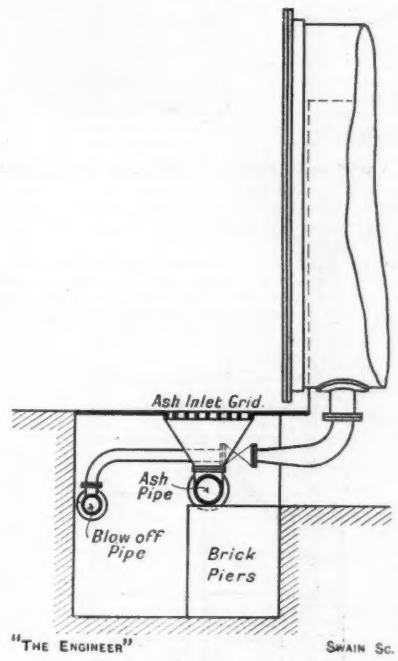
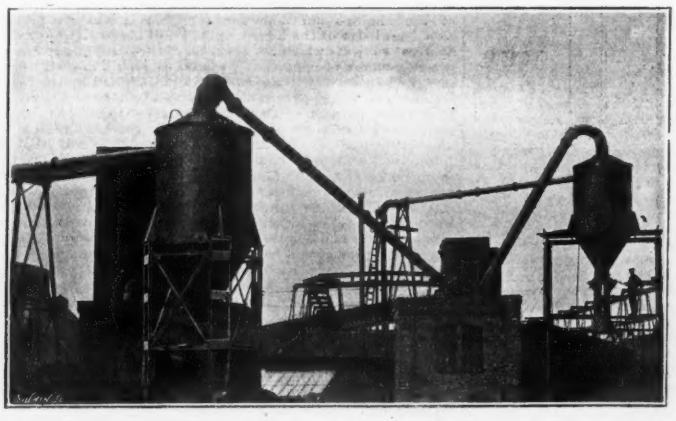
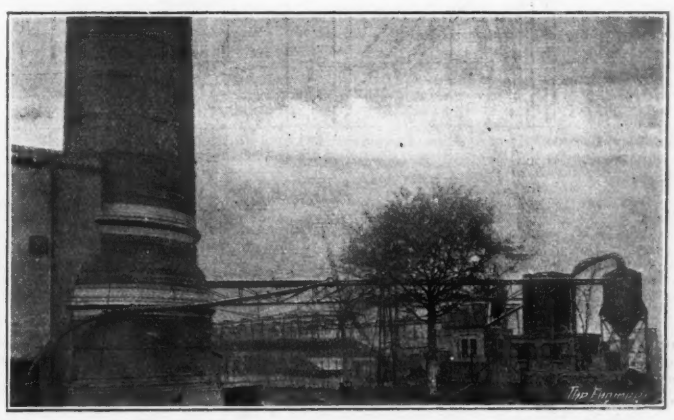


Fig. 2—ASH INLET GRID AND PIPE

flanged ends and copper asbestos joints. They are generally carried on brick pillars built into the blow-off trench.

Whenever the pipes are subject to a change of direction,

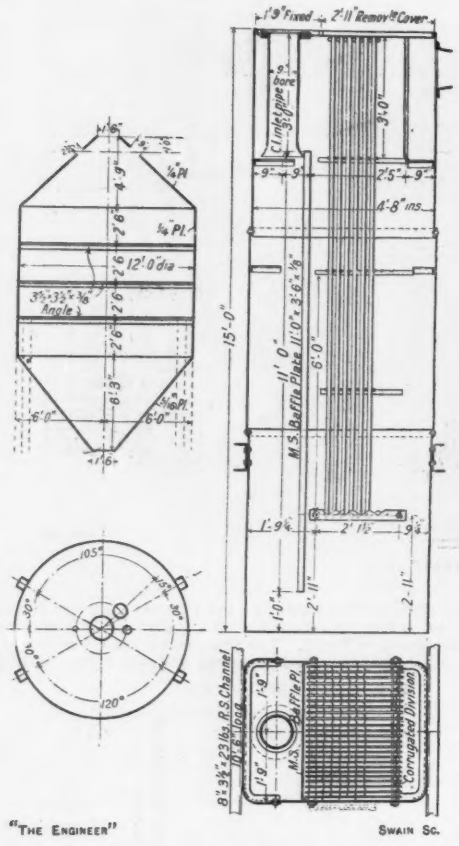




Figs. 3 and 4—BENNIS ASH-HANDLING PLANT IN A LARGE FACTORY

bends of a special type patented by the firm are provided to resist the wear, which may be considerable at these places. The wearing parts are of chilled iron, and are easily renewable. It is one of the curious properties of

suction ash plants that wear only takes place at the actual bend where the direction of the pipes is changed. Long straight lines of pipes do not appear to suffer to any considerable extent, the ash, apparently, keeping in the centre of the pipe where the air is travelling at its highest velocity. A hand hole, provided with an air-tight door, is arranged at each end of every bend, so as to enable any obstructions, which may accidentally become lodged in the pipes, to be removed.



Figs. 5 and 6—ASH RECEIVER AND AIR SCRUBBER

The ash receiving tanks, which are cylindrical in shape—see Fig. 5—and may have a capacity of, say, 20 tons each, are built of mild steel plates lined with brickwork, angle iron rings being provided inside the trunks to support the lining. The top of each tank is coned to meet the end of the ash pipe line, whilst the bottom is hoppered to allow the ashes to be freely discharged. A "Bennis" patented balanced discharge valve is provided at the outlet from each tank, so as to allow of the required quantity of ashes to be delivered into the railway or other trucks drawn underneath the delivery shoot for the purpose. In the illustration, Fig. 1, only a cartway is shown, but in other cases lines of railway are provided. In this discharge valve the rotation of a hand wheel first loosens and then releases a catch, which allows a sealing door or valve to drop, which it does gently, since it is balanced. A rotary discharge valve, water sprays, &c. The latter are arranged inside the upper coned portion of the tank. From the bottom of the tank a pipe is taken into a sump to get rid of any excess water which may accumulate. This pipe is water sealed in the sump.

A much larger pipe than those used for conveying the ashes is connected to the upper portion of each tank, and through it the air passes to a cleaner or scrubber. This apparatus, which has been patented by the firm, and which is shown in Fig. 6, consists of a water-sealed vessel filled with rows of water-sprayed bafflers, the duty of which is to catch any dust or fine particles of ash which might otherwise be carried into the exhauster. The water seal at the bottom acts as a safety valve in case of undue pressure or vacuum in the apparatus. An example of an installation erected by this firm in which there were two ash receivers is shown in Figs. 3 and 4.

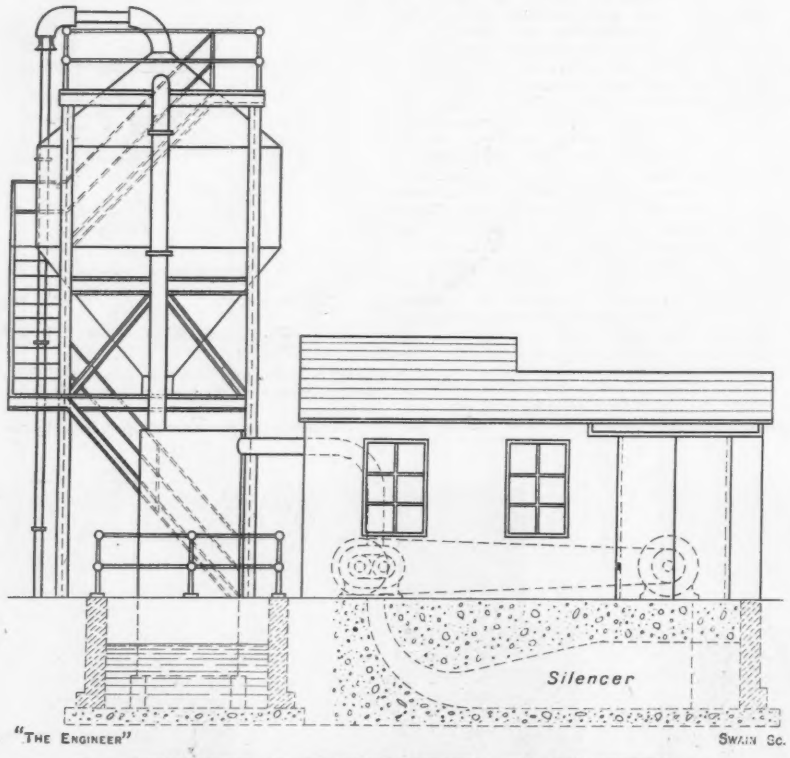
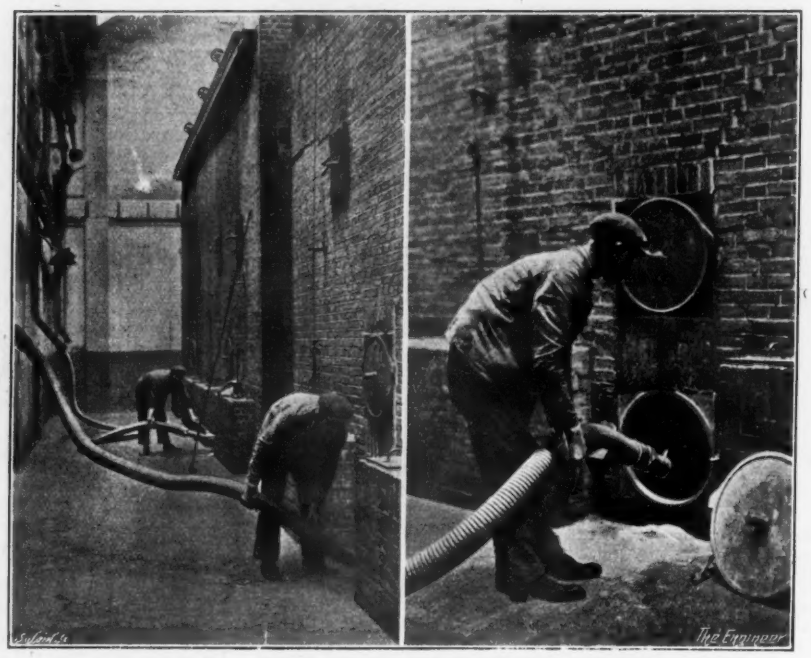


Fig. 7—ARRANGEMENT OF EXHAUSTER, CLEANER, AND ASH RECEIVER

The air exhauster is of the rotary type, and it varies in capacity with the amount of ashes, &c., which has to be dealt with. Messrs. Bennis inform us that the suction required in their installations is considerably less than that usually required in grain elevating plants. Indeed, they state that not much more than one-half is necessary. A typical arrangement of plant is shown in Fig. 5.

As will be observed in Fig. 1, the main pipe line for removing flue dust and soot from the flues, economisers, and chimneys is entirely separate from the ash pipe, but the two pipes are, as a rule, joined together at the foot of the ash pipe leading up to the ash tank. The dust pipe main is provided with connections, to which may be attached lengths of flexible pipes, which can be taken about as desired and inserted into openings in the flues and economiser chambers, which are provided with cover plates for use when the dust, &c., are not being removed.



Figs. 8 and 9—METHOD OF USING FLEXIBLE SUCTION PIPES

The suction end of each flexible pipe is provided with a nozzle of a design which has been patented by Messrs. Bennis, and which, so they inform us, cannot choke, even though it be plunged into a large heap of flue dust. The attachment of the flexible pipes to the main suction pipe, and the method of using these pipes, is shown in Figs. 8 and 9.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ROYAL NAVY AND ITS ENGINEERS.

SIR,—The fact that the Admiralty is advertising through the usual channels for temporary Service Engineer-Lieutenants and Sub-Lieutenants, not only brings back a whiff of the Crimean War period when the Admiralty of that time was sorely pressed for marine engineers, but it also indicates the straits in which the Admiralty now finds itself owing to the apparent dearth of fully qualified engineers for officers' rank for the engine-rooms of vessels of war. The term "apparent dearth" is used advisedly, for there is room for the opinion that the dearth is more apparent than real. As a war measure, when improvisation is the rule, responsible critics are under the necessity of weighing every word carefully that may find its way into a public print in case of the charge of factious criticism being levelled at those who comment on the things stored away in that sacred Ark of the Covenant which, for brevity, is termed the Royal Navy.

In the advertisement with which this letter will deal, a promise is held out to a proportion of the officers who are tempted to join, that they will be absorbed into the list of permanent engineer officers. This means that when the war ends there will be a residue of engineer officers left in the Royal Navy whose previous training was not intended to fit them for a naval career, and these will clog the machinery of promotion and so retard the fulfilment of ambitious desires and legitimate hopes of the junior branch of the Naval Engineers Corps; in other words, to the engine-room artificer branch and its offshoots, such as mates (E), chief artificer engineers, and artificer engineers. These are, without any use of ambiguous phrasing, the practical engineers or handicraftsmen of the engine-room department. These make no pretence to a knowledge of the higher branches of mathematics or other abstruse subjects which are essential in the designing rooms and drawing-offices of engineering works, as such knowledge is not essentially necessary in the efficient handling and upkeep of the engines and boilers of a modern battleship, huge or diminutive. If a closer parallel of their professional attainments may be made it lies in their approximation to the engineers of the mercantile marine. So much postulated, it follows that the Admiralty, if it is to emulate the example of the War-office, should offer and make easy the way of these men to the commissioned rank of engineer officers. In pre-war days promotion was tortoise-like in its speed of progression, and now that war has been raging for three years, this progression should have been accelerated like unto that of the hare. We are fully aware that some promotions have come to the engine-room branch, but the speed has been slow, and the way tortuous. It may not be generally known that, before an engine-room artificer can attain the rank of mate (E), or a chief or artificer engineer can step into the ward room as an engineer-lieutenant, a mild form of inquisition is set up to investigate and assess a candidate's fitness—not professional fitness—for commissioned rank. These men, be it understood, may have spent any years, from fourteen to twenty, in the Royal Navy, and have been reported upon quarterly, half-yearly, and yearly, by their captains and engineer-commanders.

It requires no excess knowledge of human nature to realise how these men feel when they see rank outsiders coming over the gangways of their respective vessels with newly signed commissions in their pockets, and elevated to positions of advisory and administrative control that their subordinates have been striving for for years.

The writer contends that there are hundreds of men amongst those who joined the Navy as engine-room artificers who are

fitted in every way for higher positions and fuller responsibility, and if there are still untapped resources amongst young engineers in civil life that Lord Derby has no knowledge of, such can join the Navy as engine-room artificers and so stiffen the junior branch of the Engineering Corps. This plan would be simple, equitable, and—to use a hardworked adverb—democratic in every sense of its meaning.

The position should now be clear about the "apparent dearth" of engineer officers. If every soldier is supposed to carry a Field Marshal's bâton in his knapsack, it should not be denied to the engine-room artificer to have his place in the Sun in so far as gold lace, and what it connotes, is the summit of his ambitions, for it tends to gild a hard and strenuous existence, and what is more, it is an existence that has to be endured for many years before a full and *thorough* working knowledge of the Royal Navy can be acquired. It is admitted that some commissions have been given to the men in question. My reply to that is, and it is a crushing one, that more temporary commissions have been given in the shape of engineer-lieutenancies and sub-lieutenancies to outsiders since war broke out than have been awarded to the seasoned and well-tried engine-room artificer branch of the Navy.

It can be urged that the position of an engine-room artificer is not sufficiently tempting and its emoluments high enough for the class of men which the Admiralty expects to rope in as commissioned officers. That may be granted, but it is a dangerous argument to employ: for untempting as are the conditions, and low as the emoluments may be, they are what have been borne by the men who are now chief and artificer engineers during all their service lives.

The potential temporary service commissioned engineers that the advertisement to which reference has been made will appeal, have the preference "to do their bit" as soldiers for one shilling and twopence per day or the alternative of joining the Navy as engine-room artificers at five shillings and sixpence per day, and certainly, if they are sufficiently competent to fill the higher positions they should—if logic has any value—be fit for the subordinate position of an engine-room artificer, and so the Admiralty would get its men, and at the same time be able to promote the deserving, long-service men who have been through the turmoil of apprenticeship to service manners and customs.

In connection with the starting rate of pay—5s. 6d. per day—of an engine-room artificer, we ask, in all fairness, cannot this be improved? We are not living in the times of the Medes and Persians. Thirty odd years ago—1883 to be exact—when this rate was fixed, there was nothing much to cavil about, but since then the whole field of economic life has changed. For a decade or so before war broke out the prices of all commodities had increased considerably. This was one of the platitudes of all manual workers in the pre-war period, so now the sum of 5s. 6d. per day for a trained engineer is grotesque when it is considered what sums engineers are earning in civil employments.

It must be understood that in the Navy there are no such sweets as war bonuses, premium bonuses, and overtime rates. The writer of this letter has information from reliable and trustworthy sources that on numberless occasions the engine-room staffs of ships of war have worked the same number of hours as civilians worked, and the latter have romped off with pockets full of money whilst the service man never received, and does not receive, a single *sou* for whatever overtime he may work.

In a certain naval dockyard that has sprung into existence since war started, engine-room artificers are working side by side with civilian workmen, working the same number of hours, and doing precisely the same work, the difference being that no elaborate system of time keeping is necessary for the engine-room artificers as their pay is a fixed quantity, but for their temporary colleagues accurate time keeping is essential, as these are paid, and rightly so, at enhanced rates for all overtime worked.

This question of a scandalously low wage rate necessitates immediate rectification if we are to consider ourselves a just people. The issue on this point is simple, and is only one of £ s. d. We grant that the question of further promotions to the engine-room branch is complicated, and many subtle points not always apparent to the lay vision have to be considered.

Sufficient has been stated to show that so far as the junior branch of the engine-room staff is concerned, many grievances exist. To remove these should not prove difficult.

EX-EDITOR,
The Naval Engineering Review.

July 30th.

THE METRIC SYSTEM.

SIR,—By the accident of circumstance, the letter of Mr. J. Lingham Lees, published in your impression for October 6th, 1916, has just come to my eye. In view of the importance of the matter, I hope you will not consider the lapse of time a bar to the publication of this reply. In his letter, Mr. Lees makes reference to the report of the Director of our Bureau of Standards on "The Metric System in Export Trade," which Mr. Lees dignifies by calling it "The U.S.A. Senate Report."

This document is not a report by anybody to the Senate of the United States. As its title page shows, it was made to the International [Pan-American] High Commission by the Director of our Bureau of Standards at the request of Secretary of the Treasury McAdoo, for use by him at the International Conference of last year at Buenos Aires. The report was sent to Senator Fletcher by Assistant Secretary General Parker, with the suggestion that it be made (technically) a Senate document in order that it might be printed, without cost, in the Government Printing Office, and likewise circulated through the mails without cost, by the use of the franking privilege which Senate documents enjoy. This was done, and it is the beginning and the ending of its status so far as the United States Senate is concerned, all of which, except the motive, is perfectly clear from the document itself.

Mr. Lees says of this document that it "is nothing less than a demand from leading firms, principally engineers, for an increased employment of the metric system." It is nothing of the kind. The second paragraph of the report begins by saying "The following examples are given as a few typical of the large number of manufacturers who are already using the metric system, in some cases for both domestic and foreign trade," and that is the only sentence to be found in the document which could have been the basis of Mr. Lee's statement.

In this list are fifteen names. Mr. Henry R. Towne, of the Yale and Towne Manufacturing Company, wrote to all of these parties and published extracts from their replies in the *American Machinist* for June 8th, 1916, from which I have taken the following:—

American Locomotive Company.—"Are using the metric system when the purchaser requires it. Not a very large portion of our output. Do not favour compulsory legislation, which would work great hardship."

Baldwin Locomotive Works.—"Do not use the metric system except when specified. Indifferent as to legislation."

Brown and Sharpe Manufacturing Company.—"Strongly opposed to compulsory measures which would introduce endless confusion."

Pratt and Whitney Company.—"Are opposed to the change."

Waltham Watch Company.—No reply.

Standard Tool Company.—"Proportion of product made to metric dimensions is very small. Think manufacturers should not be compelled to adopt metric system."

Morse Twist Drill and Machine Company.—"Only use metric measures when specifically ordered. Do not favour compulsory legislation."

Bausch and Lomb Optical Company.—"Have used the metric system for a great many years in making lenses, and prefer it. In mechanical work, however, the English standards are still in use on account of the great expense that would be involved in changing. Do not advise compulsory legislation."

Eastman Kodak Company.—"Use metric system on very small proportion of product and almost wholly on export orders. Are opposed to compulsory legislation."

Lufkin Rule Company.—"Not using the metric system for manufacturing purposes, but thoroughly endorse the system. Favour compulsory legislation."

International Exporting and Importing Corporation.—No reply.

Keuffel and Esser Company.—"In our opinion there can be no doubt but that eventually the metric system will be adopted in this country as the only standard system, and that it would be best to hasten this date."

Powers-Weightman-Rosengarten Company.—"Only use metric system in a small way for occasional export orders. Favour retention of the present system."

Library Bureau.—"Originally used metric measures, but have recently changed to measures based on the inch."

L. S. Starrett Company.—"On account of the infinite labour and expense of changing, do not favour compulsory legislation."

This is all there is of Mr. Lees' "demand from leading firms, principally engineers, for an increased employment of the metric system." It is of a piece with most metric claims and statements.

As I have said above, this report was prepared for use by Secretary McAdoo at the conference of the International High Commission at Buenos Aires. It made its public appearance after he had sailed, making a protest to him in person impossible, and the result was a series of eight cabled protests sent to him at Buenos Aires from some of the leading commercial, manufacturing, and financial interests of this country. These protests checkmated a little game to morally commit this Government to the adoption of the metric system through resolutions at Buenos Aires.

The report is now too old to justify an exhaustive analysis of its misleading character, but I will give two instances. The report says: "Some well-meaning men have urged that English measures were working well enough, and a change would be all but impossible. Yet the very firms concerned are using the metric system for their own profit. No more could be asked." Among the "well-meaning men" included in this reference is Mr. Henry D Sharpe, of the Brown and Sharpe Manufacturing Company, and to what extent is the Brown and Sharpe Manufacturing Company using the metric system? Among the products of that company are vernier calipers, height and depth gauges. The Brown and Sharpe Company have found a call for these instruments in metric countries and they, therefore, have engraved upon them metric scales and verniers with no other change in the instruments. They make micrometer callipers. These also are supplied to metric countries to read in millimetres. They make snap (calliper) gauges, which, for sale abroad, are ground with the gaps of metric dimensions. They also make gear cutters and, for use in metric countries, they furnish these to metric pitches. I might extend this list, but that is not necessary, for the above is sufficient to show the manner in which the Brown and Sharpe Company "are using the metric system for their own profit." As a matter of fact, they are the leaders of the opposition to it in this country.

Your well-informed readers are aware of the manner in which Mr. S. S. Dale has exposed the state of confusion into which the attempt to adopt the metric system has plunged the textile industries of metric countries. This disclosure is the most exhaustive and illuminating that has ever been made, and it shows the hopeless confusion that results in any industry from the attempted adoption and the resulting partial adoption of the metric system. The disclosure is a monumental piece of work and a contribution of the first order of importance to real information on this subject. The report in question dismisses this in one sentence: "In the textile industry, for example, one outspoken writer—not a manufacturer—speaks disparagingly of the metric system."

The above citations are enough to show your readers the character of this report, which, far from being "a demand from leading firms, principally engineers, for an increased employment of the metric system," is a piece of special pleading from our metric hothouse, the Bureau of Standards, intended to carry to South America a false impression of the progress of the metric system in this country. It was received with indignation by many of those whose names were lugged into it, and, more than any other one influence, it was, by reason of its hopelessly misleading character, the cause of the organisation of this Institute.

F. A. HALSEY,
Commissioner, American Institute
New York, July 11th. of Weights and Measures.

COAL ECONOMY.

SIR,—In THE ENGINEER for Friday last one of your correspondents "Lancastrian" refers to my letter of the 13th inst. on the above subject.

"Lancastrian," in the first sentence of his letter, indicates one of the weak spots of our present methods of steam raising, i.e., lack of control over the combustion in our furnaces. and if he will carefully re-read my letter above referred to he will find my sole aim is to create conditions which will automatically improve the quality of combustion, and, therefore, increase boiler efficiency.

Your correspondent further adds that most engineers will not dispute my figures as to the quantity of coal that might be saved by better combustion, and yet we keep moving round and round in the tracks of our ancestors; we make no effort to improve the conditions which are robbing the nation of over 100 million pounds sterling per year, fouling the atmosphere with the products of imperfect combustion, and laying the foundations for our winter fogs, and adding to our annual death rates. Every cubic foot of black smoke carries 2 grains of coal, and as 300 to 350 cubic feet are provided per lb. of coal we have proof that during a smoky period 10 per cent. of the coal fed to the fires is escaping from the chimney, and as, with good combustion black smoke is not possible, this loss is over and above that due to waste heat through excess air.

To save 50 million tons of coal per year is not a difficult problem, and if the lines laid down in my last letter were adopted at once, the country could be reaping the benefits in two or three weeks' time, and seeing this economy is possible, why not treat transgressors by the same rule as those who waste bread?

"Lancastrian" has doubts as to the possibility of effecting economy by reducing the area of the boiler furnaces, and goes so far as to state that with fluctuating loads as in dye works, bleach works, &c., it would be absurd: and yet he says "It is a recognised fact that for good combustion a definite relation must exist between the air supplied and the coal burnt."

To secure the conditions asked for was the sole object of my previous letter, and it can only be effected by so arranging that in all diameters of Lancashire boilers, a fixed ratio—2 to 1—exists between grate area and sectional area of furnace flues at the rear end of the boiler, instead of, as at present, the length of the grate being the constant.

To illustrate my meaning, consider an ordinary Lancashire boiler 30ft. long by 8ft. diameter, grates 6ft. long, the total grate area will be 39 square feet, and sectional area at the downtake 12 square feet, so that 3¼ square feet of furnace is provided for each square foot of outlet, and experience has demonstrated that this proportion should not be more than 2 to 1, that is if the best results are desired.

With a fire grate 6ft. long it is a difficult thing for the attendant to maintain the same thickness of fire at the back end as at the front, and it is probably this cause which is responsible for such a large excess of air finding access to the furnaces, and apart from this fact a large grate is of little service unless the outlet for the gases is made proportional.

By reducing the length of the 6ft. grate to 4ft. thicker fires can be used, the excess air minimised, and furnace temperature and the evaporation per lb. of coal increased.

With 25 lb. of air per lb. of ordinary steam coal, the furnace temperature is 1800 deg., but with 15 lb. of air the temperature is approximately 2500 deg., and as the radiating powers of a furnace increases over 50 per cent. by an increased temperature of 25 per cent., that explains how and why a reduced grate area gives both a higher steam duty per hour and also increased boiler efficiency.

That we cannot have both the halfpenny and the toffee is well illustrated here, as we cannot have the heat for steam raising which we have already expended in raising 10 lb. or 15 lb. of excess air—used per lb. of coal—from atmospheric temperature to 1800 deg.

Near enough for my present purpose, I will assume the chimney draught as constant; the volume of gas taken from the furnaces will therefore be governed by the sectional area of the furnace flues at the rear of the boiler, hence the importance of a constant ratio between this outlet and the furnaces.

There are, of course, several other factors which tend in the direction of economy, i.e., preventing in-leakage of air through the brickwork of the external flues, keeping the downtake in good condition, stoking the fires from front to back and on one side at a time, and never stoking when the chimney is still smoking. To assist the stoker at our works we have a CO_2 indicator which enables him to know at a glance the condition of his fires as easily as the gauge glasses and steam gauge enables him to know the position of the water and steam pressures.

I am so satisfied with the possibilities of the lines laid down in my letter of the 13th inst. that if "Lancastrian" can produce a hand-fired Lancashire boiler 30ft. long, fitted with grates 6ft. long, he shall test this boiler both for duty and efficiency; the grates shall then be reduced to the proportion of 2 to 1 already referred to, and he shall then test the boiler in exactly the same way, and if the results are not a greater evaporation per hour, also per lb. of coal burned, I shall be willing to pay £10 for the benefit of the wounded soldiers in the town where the test is made.

In conclusion, I would respectfully call your readers' attention to the last paragraph in my letter of the 13th inst. already referred to.

W. H. CASMEY.

Wakefield, July 30th.

THE CHARING CROSS RAILWAY BRIDGE.

SIR,—It appears the railway company has obtained permission to strengthen the bridge to make it safe for the increased weight of rolling stock necessary for present and future requirements of heavy traffic: but the railway station is in the wrong place for heavy traffic. It would be better placed on the south side of the river. To build a new station, remove the existing bridge, and build a new one for ordinary traffic would be a very costly undertaking. The congestion of traffic approaching the new bridge would be very great, because of the traffic moving north and south crossing the traffic going east and west.

The construction of the new bridge would be a very large item in the total expenditure if such a scheme were carried out, and there would be congested traffic.

The scheme I am about to propose would avoid the necessity of building a new bridge, and would also avoid congestion of traffic. The north and south traffic would cross that going east and west overhead, and the present railway bridge would be utilised, making it unnecessary to build a new bridge.

The scheme generally may be thus described:

The station would be placed on the south side of the river, and the present bridge altered so as to be used for ordinary traffic crossing the river to and from the station. There would be a carriage and footways at the present rail level, and also similar carriage and footways on the upper booms of the girders. The lower ways would take the traffic approaching the bridge from east to west, and the upper ways the traffic coming from north to south. A viaduct would be constructed from Seven Dials running at the east of St. Martin's Church to the upper roadway and crossing the Strand on arches or columns. The north and south traffic would then cross the east and west traffic overhead.

It might be possible to improve the appearances of the bridge and at the same time reinforce its members by the use of concrete; at all events there do not appear to be any engineering difficulties which would form a serious objection to the scheme.

There might be a difficulty on the south side in having the upper roadway so high, and a modified scheme would be to bring the viaduct from Seven Dials to the rail level, and only have the lower roadway for the north and south traffic, and if the bridge were widened the present rail level might also take traffic from east and west.

Such a scheme as I have outlined would relieve the present great congestion of traffic caused by the north and south traffic crossing the Strand at the approach to Waterloo Bridge, and avoid congestion of traffic at Charing Cross.

HENRY DAVEY.

Ewell, Surrey, July 30th.

THE BRITISH ENGINEERS' ASSOCIATION.—The fifth annual ordinary general meeting of the British Engineers' Association was held at Caxton Hall, Westminster, London, on Thursday, July 26th, and was attended by a large number of representative members from many parts of the country. In moving the Council's report, balance sheet and income and expenditure account for the year ending December 31st, 1916, which had been issued to all members, the chairman—Mr. Wilfrid Stokes—reviewed the work done by the Association during the past year, and dealt with the action which it was proposed to take in future. The new Memorandum and Articles of Association, which had been revised in accordance with the resolution passed at the extraordinary general meeting of the Association on July 13th, 1916, had received the sanction of the Courts, and were now operative. At the first meeting of the Council, held the same day, Mr. Wilfrid Stokes was re-elected president, and the Council now stands as follows:—President: Mr. Wilfrid Stokes. Vice-presidents: Mr. T. O. Callender, Sir John Cowan, Mr. Peter Denny, Mr. Herbert Marshall, Captain L. E. Mather, Mr. J. E. Thornycroft, Mr. Douglas Vickers. Members: Mr. Daniel Adamson (Joseph Adamson and Co.), Mr. H. Allcock (W. T. Glover and Co., Limited), Mr. H. Austin (Austin Motor Company, Limited), Mr. Stanley Brotherhood (Peter Brotherhood, Limited), Sir Edwin Grant Burls, C.S.I. (Vulcan Foundry, Limited), Mr. George Cradock (George Cradock and Co., Limited), Mr. Robert Goudie (Loudon Bros., Limited), Mr. John Hemming (F. H. Lloyd and Co., Limited), Dr. G. B. Hunter (Swan, Hunter and Wigham Richardson, Limited), Mr. John Hunter (Sir Wm. Arrol and Co., Limited), Mr. A. Jacob (British Aluminium Company, Limited), Mr. Christopher James (Joshua Buckton and Co., Limited), Mr. J. R. C. Kearns (H. W. Kearns and Co., Limited), Mr. B. Longbottom (Electromotors, Limited), Mr. Hugh Lupton (Hathorn, Davey and Co., Limited), Mr. C. P. Martin (C. A. Parsons and Co., Limited), Mr. A. E. Owen (Rubery, Owen and Co.), Mr. Henry Steel (Steel, Peech and Tozer, Limited), Mr. T. Cuthbert Stewart (Stewart and Lloyds, Limited), Mr. H. J. Ward (J. and E. Hall, Limited), Mr. J. C. Ward (Edgar Allen and Co., Limited), and Mr. A. P. Wood (The Lancashire Dynamo and Motor Company, Limited).

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

The Manufactured Iron Trade.

The tone of the market still continues strong. There is a large volume of business in finished iron, but the Government restrictions render the market largely insusceptible to the influence of a demand which exceeds supply. Competitive bargaining in the ordinary sense has almost ceased. The question of delivery is now all important. Even there the control has taken matters much out of the hands of the trader. Iron merchants complain that they are receiving less and less attention from the iron mills on which they rely for supplies. There is no possibility of renewing stocks of finished iron, since deliveries are subject to such long delays that they are all forestalled. Business in uncontrolled material is so largely contingent upon the exigencies of the controlled branches that there is no real freedom in the buying and selling market. The demand for best and common bar iron is very active, and a large amount of buying is reported for hoops, thin sheets and small rounds. Strip is in great request, and brisk booking is done by the makers of small sectional iron. Consumers of puddled bars still loudly complain about the limited supplies available. Some makers refuse all offers, as they cannot turn out enough for their own mills.

Ironworkers' Wages.

This week the Midland Iron Trade Wages Board has issued the result of the accountants' examination of the manufactured ironmasters' books for the period of May and June last for the determining of ironworkers' wages. The return shows that puddlers' wages for the months of August and September will be 18s. per ton, which is a continuation of the present rate, and millmen's wages in proportion. The average net selling price is certified to have been £15 6s. 0.88d. per ton, as against £15 5s. per ton in March and April last. It is instructive that the average net price of the several classes of iron making up the return were :—Bars, £14 17s. 5.22d.; angles and tees, £15 6s. 11.55d.; plates and sheets, £18 6s. 11.12d.; and hoops, strip and miscellaneous, £16 4s. 7.56d. Since the beginning of this year ironworkers' wages have advanced in the aggregate 7½ per cent.

The Pig Iron Trade.

Increasing pig iron supplies are required for France, and sales have also been made on account of Italy. The freer issue of shipping permits is connected by some furnace owners with the entry of the United States into the war. The theory is that America now needs for home consumption material which she has been sending to the Allies. A substantial tonnage of pig iron is being sold. Most consumers recognise that the supreme consideration now is to make sure of the raw material, and they are placing orders very freely. The belief is entertained this week in the pig iron trade that the Ministry has it in contemplation to tighten up the control over pig iron, particularly with reference to the problem of distribution. It is probable that the appropriation of the iron ore mines of Cumberland and Lancaster, which has just occurred, is the first step in a fresh policy which will make the restrictions on the trade more stringent. A large part of the pig iron output has been sold over the next two months, and prospective supplies beyond that period are also mortgaged. Some of the furnace owners have changed their attitude recently, and are accepting all orders offered on the ruling terms. Others, however, are still limiting their commitments, arguing that they have nothing to gain by filling up order books. There is no pig iron to be bought under the full maximum prices. Some pig iron firms have now gone on entirely to the making of basic iron, or to the production of special irons, generally for casting purposes, to meet the enormous demand for high-class machinery.

Coke.

Foundry coke contracts were to-day (Thursday) in Birmingham repeated at oven quotations, which in some cases meant over 40s. per ton delivered to works, and furnace cokes were in active request.

Steel Trade.

Steel is scarce. For the most part shipments from America consist of wire rods, which cannot well be done without. Every circumstance shows the determination of the Government to bring up the steel trade to war requirements. Numerous works extensions are in progress with the object of increasing the output. It is impossible to get any order through unless it is especially earmarked for the war. Steel makers are feeling anxious about the receipt of fresh circulars of instructions from the Ministry. According to these, they have to specify accurate details, and return concise information of the articles to be produced from the material, the quantity, sizes, whether for stock or for running account, destination, whether for war work or not, and rate of delivery. It is contended that the instructions are framed in such a way that it is impossible to conform with some of them.

Advance in Wire Prices.

The heavy demand for steel wire on the part of some of the Birmingham light trades continues to send up prices, and an advance of £4 per ton has just been declared by the associated makers, bringing the basis up to £56 per ton. This follows an advance a couple of months ago of £5. Some makers even ask a premium of £2 to £3 a ton on the new figure, since the supply is much smaller than the demand. Many consumers are unable to get enough material to cover their normal wants, apart from the requirements of the Government. Wire rods and hollow blooms are coming from America, but the consignments are not large, and the prices are inflated. Wire rods realise £29 to £30 at Liverpool.

Iron and Steel Scrap.

Scrap of all kinds is scarce. After showing some little animation, the market for wrought iron scrap has relapsed into quietude. Complaints are still feared that the price has been so severely limited as to discourage business.

The August Holidays.

The majority of war workers in the Birmingham district will enjoy a welcome holiday next week. Enquiries made from many of the principal firms show that the bulk of their employees, with the consent of the Ministry of Munitions, will cease operations for at least a week. Some will cease work on the Friday immediately preceding Bank Holiday, others on the Saturday, and will not be required to resume work until August 13th.

LANCASHIRE.

(*From our own Correspondents.*)

Manchester, Thursday.

Iron, Steel, and Metals.

The markets for iron and steel are generally quiet and uninteresting, except to those few people who are making money out of them, and they are but a very small number now. Some merchants are busy in the work of distributing material against Government contracts, but one does not see how this work can bring in more than enough to cover office expenses, even if it does as much. It is noticeable that the stock-holders who form a class by themselves find it extremely difficult to carry on business or to keep their stock in tolerable order ; and it is probable that if more business were allowed to be done through the stock-holders a real economy would be effected, even although the prices to be charged for the iron and steel are, of course, higher. The economy would result from the increase in the size of the orders sent to the manufacturers for one particular section or class of material. It is false economy to send a small assorted order direct to the maker, especially when there is need for urgent delivery. It is time to put in a plea for the stock-holder as well as a plea for the ordinary iron and steel merchant, not only in the interests of trade, but in the interests of national economy.

Foundry Iron.

The market for ordinary foundry pig iron remains very dull, and it is difficult to find a report of any sale. The total of the July sales in this district will certainly be under that of June, and probably considerably less. When these figures are made up it is possible that sellers will look more closely after business ; but if previous experience is any guide there will be no revival of buying for the first two weeks of August. The latter part of August is, however, often an active time in the Manchester foundry iron market, and if the usual thing is repeated this year, sellers will be quite satisfied ; if not, however, there may be some anxiety to sell leading to competition. We have been without competition in this market for so long that a change would be welcome ; and even if prices had to be lowered sellers would find a good deal more interest in their work. Probably it is too much to expect that any revival of " bear " selling can take place during the war, as speculation is now considered to be one of the seven deadly sins ; but it would do the trade all the good in the world. Derbyshire No. 3 is still quoted at 98s. 8d., including merchant's profit of 1¼ per cent., and Staffordshire at 102s. 6d., and these are the two principal irons offered here now. Apparently the demand for foundry iron in the Midlands is better than it is in Lancashire, and consequently there is no inducement to send here those brands which would go into the Midlands at a lower rate of carriage. Some small sales of No. 1 Derbyshire at 102s. 9d. per ton, and No. 1 Staffordshire at 107s. 6d. take place occasionally ; but there is not much of this business, owing to the shortness of supply. The Scotch makers also seem unable to spare very much foundry iron for Lancashire now, and there is a tendency to get behind-hand with the deliveries. The demand for Scotch iron is also quite small.

Forge Iron.

Merchants here are now doing very little in forge iron, a good part of the business going direct ; hence very little is heard about it in the market, but I understand that there is a steady demand at the full maximum prices.

Steel.

American billets are not offered here, and the only foreign material one hears of is a little steel wire rod. The ostensible price for this is still £30 per ton, and although the thing seems incredible it is to be presumed that some consumers are able to pay that figure.

Scrap.

In the present quiet state of the foundry trade of the district it is natural that there should be no very distinct demand for cast scrap iron, and that dealers should be doing very little. The prices, however, do not fall at present, and scrap dealers—like pig iron sellers—are no doubt waiting for the August revival. There is no overwhelming quantity of cast scrap coming on the market at present, and it is probably safe to avoid pressing any lots just now. The better qualities of this class of scrap, more especially the broken castings from spinning machinery, are comparatively scarce, and dealers still ask 112s. 6d. per ton for them. For ordinary good heavy cast scrap 102s. 6d., and perhaps a little less, would be taken. Steel scrap for melting purposes is nominal at 105s. on trucks, but so far the demand from South Wales has not returned, and there is practically no inquiry from the North-East or from Sheffield. Lancashire has done without the latter market for so long that people here have ceased to take an interest in it ; but it is certain that the local demand for steel scrap cannot deal with all that is made in Lancashire. That would be the case in regard to wrought iron scrap; but unfortunately the trade in this department is held up by the regulations. I do not know that any trade is being done, but if transactions are put through they cannot be arranged at the official prices, that is if the scrap is all of prime quality. There are rumours that consumers are accepting wrought iron piping as heavy scrap ; and if the regulations admit of this being done then it may be possible to supply scrap at £5 15s. Steel turnings are supposed to be limited to 50s. per ton, but only inferior lots of small turnings can be obtained at this figure. Good heavy steel turnings are worth nearer 65s.

Metals.

The prices for copper have not again been altered. Strong sheets are quoted at £160 per ton. Merchants here quote English ingot tin at £250.

Light Railways in Trafford Park.

The inquiry made by the Light Railway Commissioners into the proposal of the owners of Trafford Park to construct further light railway accommodation came to an end last week by a compromise. The owners of the park had a project for two lines, one from Barton to Stretford for commercial purposes, and to run from the Barton entrance to a point near the British Westinghouse works, and the other, called the Lostock line, to carry passengers from the park to Urmston, an adjoining suburb. On the other hand, the trustees of the De Trafford estate proposed a line of light railway from the Stretford entrance to the park, and running in a north-westerly direction to the boundary of their land. After conferring it was agreed that the proposal to construct the Barton and Stretford line should be withdrawn. There would be no opposition to the De Trafford railway or to the Lostock railway, subject to the Estates Company giving up to the De Trafford trustees a strip of land between the Bridgewater Canal and Lostock Road in exchange for land near the Bridgewater Canal at Barton. The Lostock railway was to be used for passengers and the carrying of small parcels, and the De Trafford railway was to be the only line authorised to carry goods. The Commissioners sanctioned the agreement.

Manchester School of Technology.

Readers of The Engineer will be interested to learn that Mr. Dempster Smith, late of the above school, and well known to all mechanical engineers on account of the excellent work which he has done in connection with tool steel, has given up teaching for practical work. He is now connected with the firm of Mirrlees, Bickerton and Day, Limited, Hazel-grove. Mr. G. Gerald Stoney has been appointed professor of mechanical engineering at this school. Mr. Stoney has had a seat on the Board of Inventions and Research and on the Engineering Committee of the Advisory Council for Scientific and Industrial Research.

Barrow-in-Furness, Thursday.

Hematites.

There is marked activity on every hand in the hematite pig iron trade of this district. The demand for iron is fully maintained—in fact is, if anything, rather fuller than of late, and makers hold big contracts that represent a busy state of affairs for some time to come. There are thirty furnaces in blast. Of this number six are at Barrow, two at the North Lonsdale Works at Ulverston, one at Carnforth, one at Askam, four at Millom, ten at Workington—Derwent having four, Moss Bay one, Oldside two, and Lowther one, whilst at the Solway Works there are two blowing, and one at Cleator Moor and one at Distington. Prices are at the maximum rate.

Iron Ore.

There is a very heavy demand for iron ore. Local smelters alone could account for the whole of the tonnage raised, but, in addition, there is a good call for ore on the part of outside users. The taking over of the iron mines of Furness and Cumberland may lead to a fuller output, but more labour is required, and although huts have been erected at Millom and Askam they are as yet unoccupied.

Steel.

The steel trade, whilst presenting no new features that can be touched upon, shows a very busy state of affairs. There is a big demand for semi-manufactured sorts of steel, on local as well as general home account, and the whole of the available plant is engaged and is putting up a good output. The steel foundries are also fully employed. There is a good call for steel shipbuilding material, including plates; but as yet nothing is being done here in plates, the mills not being ready for work. Prices are steady, with heavy rails at £10 17s. 6d. to £11 10s.; light rails, £14 to £14 10s.; heavy tram rails, £14 ; billets, £12 ; ship plates, £11 10s.; and boiler plates, £12 10s. per ton.

Fuel.

For coal the demand continues to be very brisk. Good steam sorts are quoted at 25s. to 27s. 6d. per ton delivered from Lancashire or Yorkshire pits, and house coal is in fair demand at 27s. 6d. to 37s. 6d. per ton delivered. There is some buying to cover the winter. The demand for coke is brisk, and East Coast qualities are at 33s. to 35s. 6d. per ton delivered, and Lancashire cokes are quoted at 31s. per ton delivered.

Barrow and the Coal Controller's Scheme.

At the meeting of the Barrow Town Council on Monday it was decided to send a deputation to the Coal Controller with a view to getting Barrow placed in the Lancashire and Yorkshire area under the coal control scheme. The Mayor pointed out that if Barrow had to obtain its supply from Northumberland it would represent an increased cost per cwt. of 3d. to 4d., and an increased cost to the Corporation gasworks of between £6000 to £7000. These increases were on carriage alone, and therefore, so far as Barrow was concerned, the scheme would be the reverse of economical.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE Cleveland pig iron trade continues to display a healthy activity in all its branches. This week business has been very brisk in connection with the home trade allocations. These show a marked revival of buying from Scotland, where the dulness, due to the holiday period, has now given place to renewed activity. On the other hand, the requirements of the North of England foundries are rather below the average of the last few months. This is in a large measure due to the lessened demands in the Tees-side district, where the August holidays now approaching will necessitate a considerable reduction in deliveries of iron. At the same time, there is no lack of foundry iron, and it is suggested that the surplus in August due to the holiday period might well be licensed for export, thus enabling the makers to dispose of it at a good price, without detriment to home consumers. The export side is steady, and some substantial shipments are reported. For home consumption, No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge all stand at 92s. 6d., with a premium of 4s. for No. 1. The export quotations are :—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

Whilst the East Coast hematite pig iron trade has shown no material change during the week, the prospects are all in the direction of an increasing stringency. The requirements of users are extremely heavy, not only on local, but general home account as well. The amount available for export is strictly limited, and only a small proportion of the huge demand can be promptly satisfied. The home maximum price of East Coast mixed numbers stands at 122s. 6d., while the foreign quotations are still quite nominal at 137s. 6d. for France, and 142s. 6d. for Italy.

Iron-making Materials.

There is a continuous inquiry for foreign ore, but only a moderate amount of new business is being put through, as sellers are already heavily committed far ahead. Coke is in adequate supply. Good medium furnace kinds are around 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

Nothing could exceed the present activity in the manufactured iron and steel trades on the North-East Coast. So far as steel is concerned, the increasing requirements of the Government have made further restrictions necessary, with the result that considerably less material can be set aside for the ordinary home or export trade, only shell discard steel being available for these purposes. The activities of the Shipping Controller and those associated with him in the building and equipping of vessels required to take the place of those put out of service through the exigencies of the war, have greatly added to the pressure in steel-making establishments. The Director of Steel Production has issued a circular this week, explaining the conditions under which stock permits are issued to merchants, to enable them to obtain supplies, and stating that these conditions must be literally carried out. It appears that a holder of a permit must only sell any steel made by the open-hearth or Bessemer process—other than shell discard quality—steel goods or goods containing steel, provided that the buyer produces a permit to buy such goods in the form of a declaration that the material required is wanted for a specified Government contract, or a Ministry of Munitions permit reference and number classification "B" or higher. The Director calls attention to the circumstance that in consequence of these conditions not being conformed to in some cases that the holder who observes them strictly is placed at a disadvantage compared with his competitor, and adds that offenders, who thus take an unfair trading advantage, run the risk of being prosecuted. While general business in manufactured iron is greatly restricted, there remains an ample sufficiency of Government orders to keep things going at high pressure for a considerable period ahead, practically the entire output being absorbed. The principal quotations for home trading are as follows :—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export :—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ⅜in. and upwards, £13 10s.; $^{5}/_{16}$in., £13 15s.; ¼in., £14; $^{3}/_{16}$in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

The New Steel Works at Warrenby.

The vast extent of the enterprise which has been launched by Dorman, Long and Co., Limited, at Warrenby, some eight miles from Middlesbrough, was revealed for the first time this week by the chairman of the company, Mr. A. J. Dorman, at the annual meeting. The scheme, he said, consisted of a 400-ton mixer, ten large steel furnaces, a cogging mill and two large plate plants, and the cost would be somewhere in the neighbourhood of two millions. Already three furnaces are at work, and a fourth will be ready in a week or two, to be followed by others as soon as they can be got ready. When completed, these new steel works will produce from 300,000 to 400,000 tons of steel per annum, bringing the total capacity of the firm's combined concerns up to an annual output of one million tons. Something like 5000 to 6000 men will find employment at these works when the present developments are completed.

Realised Prices of Manufactured Iron.

The accountants to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trades of the North of England have certified the average net selling price of iron rails, plates, bars and angles for the two months ended June 30th, to have been £13 10s. 9.87d. per ton, as compared with £13 9s. for the previous two months, and in accordance with the sliding scale arrangement, the wages in the trade for the months of August and September will be the same as prevailed during the preceding two months. The total output for the two months was 8685 tons, of which 8284 tons were bars, which averaged £13 10s. 10.82d.; 254 tons of plates, which averaged £12 17s. 5.61d.; 125 tons of angles, which averaged £14 3s. 6.22d., and 21 tons of rails, which averaged £16 5s. 9.52d. In the previous two months, 7610 tons of bars were sold at an average price of £13 9s. 4.52d.; 587 tons of plates at £13 15s. 4.25d.; and 271 tons of angles at £12 4s. 8.58d.

Scrap.

While there is still an enormous demand for scrap for steel works purposes, conditions on the whole are a little easier, a number of consumers having succeeded in covering their requirements. The trade in heavy wrought iron scrap is, however, still held up completely, and waits for a revision of prices. No doubt, dealers must be getting some scrap in, but how much it would be difficult to say, and as they have had to pay the full official price for it, and in some cases a commission as well, it is not possible for them to let it go until buyers are to be allowed to pay more. Many consumers, it is stated, are quite prepared to pay much more than the maximum price, and then would be making a good profit out of its use. Cast iron scrap of ordinary quality is difficult to dispose of just now, as foundries are well stocked. Current prices are :—Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates, and sectional material, ⅜in. thick and over, £6 5s.; heavy wrought iron scrap, ¼in. thick and over, £5 5s.

The Coal Trade.

Business on the Northern coal markets has not been particularly brisk at any time during the past month, but this week has witnessed a marked falling off, and the trade generally is somewhat depressed. The new orders governing the trade are wholly responsible for the present state of affairs. A week ago a general opinion prevailed that matters would quickly improve, but expectations have not materialised. The dead-lock in movement continues. The amount of inquiry from neutral quarters is small indeed, and practically nothing in the way of new business is being done. Prospects of a change in the condition of things are not bright, and at the same time there is a good deal of grumbling at the turn which matters have taken. Reports from the collieries remain unsatisfactory. Northumberland steams continue, as a rule, in a very bad way, but there is, on the other hand, reported to be a shade of improvement as regards Durham gas coals, but it is nothing of importance, and may be but ephemeral. Collieries all round are, as a rule, losing time heavily. Quotations are as follows :—Northumberlands : Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s.; North Northumberland smalls, 20s.; seconds, 18s. 6d. Durhams : Steam—locomotive—28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; best, 25s.; superior, 30s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

Output of Ironstone.

The Cleveland mine owners have, this week, issued a strong appeal to the miners to increase the output of ironstone. They point out that steps have been taken by the ironmasters to put additional furnaces into blast. From August onwards a larger output of ironstone will be required, and in order that the number of men to be imported into the district may be kept as low as possible, the owners appeal to their employees at the mines to curtail the amount of lost time. Since the beginning of the present year the avoidable lost time has averaged 6½ per cent. If it were reduced by about one-half, there would be no present necessity to introduce strangers, but unless there is an improvement in time-keeping the owners will no longer feel justified in urging on the Ministry the undesirability of introducing men from other districts into Cleveland.

SHEFFIELD.

(From our own Correspondent.)

The Holiday Break.

ARRANGEMENTS have been made for closing down practically all the works for a long week-end, operations being suspended generally from to-day (Friday) until Wednesday. In many cases, however, the holiday break will be much longer, in some instances extending to ten days. This is not altogether to meet the wishes of workers, who desire a longer holiday—though that desire in most instances is a pretty strong one—but to enable the firms to undertake the detailed stock-taking now necessary in order to comply with various Government regulations, and also to provide an opportunity for carrying out some of the repairs to machinery and plant so long overdue. During the engineers' strike, a few months back, an excellent opportunity presented itself for this sort of thing, but, of course, no men could be secured to execute the work, so the time was simply wasted. Since then efforts have had to be made to overtake arrears of production caused by the stoppage, with the consequence that at many works engines and machinery require serious overhauling, which cannot be carried out in a day or so. The workers themselves can undoubtedly do with the rest which the break enables them to take, for some of them, while earning very high wages, it is true, have had to work long hours for them. I have just heard of a case in which a man worked over 100 hours in one week. Most of the engineers are on day work, but repetition jobs are done at piece rates. One of the most remarkable instances of high wages was recently revealed. For an average week of 70 hours a man has averaged just over £20 per week. After that it will not be considered surprising that youths of 21 can earn over £6, and boys of 15 years 35s. a week and more.

Increased Rates of Wages.

The increase of 3s. per week in engineers' datal wages that came into force on the 1st inst. has been conceded to general workers also. This fact was mentioned at a meeting here the other day of about 3000 members of the National Union of General Workers, which was addressed by Mr. Will Thorne, who has recently returned from Russia. There are close upon 20,000 members in the Sheffield branch of the Union, and about 170,000 paying members altogether, with a "fighting fund" of £120,000. Mr. Thorne, referring to the 3s. advance, said they had asked for 10s. for men over 18, and 5s. for those under. The majority of the labourers were receiving 23s. 6d. per week when the war commenced. Since then they had had a 12s. increase, and now another 3s., representing an increase of 63 per cent. But the price of commodities had jumped up at least 109 per cent., so that if they had secured the whole 10s. their wages would have still been a few points lower than the cost of commodities. However, arrangements were made that before the 3s. increase was due another petition was put in for a further 10s. advance. The result of one presented for women and girls had not yet been announced, and another time he thought petitions for both women and men should be presented simultaneously. The matter to which Mr. Thorne referred was evidently that arising out of the complaint made to the Sheffield Engineering Employers' Federation by the National Federation of Women Workers, to the effect that no increase had been given to women employed in their works, although a circular had been issued by the Minister of Munitions stating that in consequence of the increased cost of living and the advances given to the men by the Committee of Production, certain increases should be given to women. That was in June. The Women's Federation contended that the increases should apply to piece-workers as well as to time-hands. There was a difference of opinion on that point, which was then referred to the Chief Industrial Commission for arbitration under the Munitions Act. Mr. Lynden McCarthy presided over a special arbitration tribunal, held in London toward the latter end of last week, and it is understood that a special investigation was undertaken into the question of the wages and conditions of employment of women in the Sheffield district. It was, apparently, the result of that inquiry that Mr. Thorne mentioned had not been received.

Mining Engineers.

Since my previous letter the Midland Institute of Mining, Civil, and Mechanical Engineers has held its annual meeting at the Sheffield University, when the following elections were made :—President, Mr. W. D. Lloyd (general manager of the Altofts Collieries of Pope and Pearson); vice-presidents, Professor O'Shea, Mr. H. F. Smithson, and E. W. Thirkwell; members of the Council, Professor W. G. Fearnsides, and Messrs. J. H. W. Laverick, G. H. Ashwin, J. H. Ashton, and J. R. Wilkinson. Thirty colliery companies have become subscribing members of the Institute, which now has a membership roll of 462. Mr. G. Blake Walker (managing director of the Wharncliffe Silkstone Collieries) was made the first recipient of the "Peake" medal in recognition of his excellent services to mining engineering interests, particularly in connection with the Institute, to the library of which Mr. Walker recently made a generous donation of books. The "Peake" medal is the memorialisation of the £1000 donation made to the Institute by Mr. G. Herbert Peake, of Bawtry Hall, and is to be presented from time to time to members who may have rendered conspicuous services to the Institute. Professor Fearnsides, of the Sheffield University, has, by the way, received from the North of England Institute of Mining and Mechanical Engineers the G. C. Greenwell silver medal for his paper on "Some Effects of Earth Movement on the Coal Measures of the Sheffield District," which he read before the Midland Institute. The medal is to be presented at the annual meeting of the North of England Institute to-morrow (Saturday).

Nitrate from Air.

An interesting proposal was made at the meeting here, on Saturday, of the Midland section of the Coke Oven Managers' Association, by Mr. E. Kilburn Scott, who put before the members a process for the production of nitrate of ammonia by electric power at coke oven plants. Mr. Scott, who is a member of the Institution of Electrical Engineers, and an associate-member of the Institution of Civil Engineers, contended that as nitrate is an ingredient of explosives, it was unwise for us to remain dependent for supplies upon our importation from Chili. One of the most striking scientific developments of the war, he added, was the way in which Germany, by fixation of atmospheric nitrogen, had become entirely independent of nitrate from Chili, and of sulphuric acid supplies. What Mr. Scott proposed was that instead of the ammonia of coke ovens being made into sulphate, it should be converted into nitrate of ammonia, the dilute acid required for the purpose to be made from air in arc flame furnaces, with energy generated by the surplus gas or waste heat of the coke ovens.

Round the Works.

Some of the steel firms here are very busy in departments concerned with agricultural implements, such things, for instance, as machine hay lifters and ploughplates. The former are largely intended for the home

market, but much of the latter work is on overseas account, and as the volume is several times greater apparently than that which passes in normal times, and does not seem altogether to be intended for immediate use, the inference is that in countries abroad, particularly South Africa and Australia, as well as at home, there is an intention to place a much larger area of land under cultivation next season. There is also a considerable amount of agricultural machinery repair work about. Another active line is steel "jumper" bars, about 4ft. long and about an inch at the nose, used for drilling holes in rock, &c. An enormous amount of high-speed steel is being produced, despite the difficulties regarding an ample supply of skilled labour at the crucible furnaces. As to this shortage, conditions vary, some firms having sufficient teemers and pullers-out—the skilled men—to keep all the crucible holes working, while others have several holes idle. On home account there is little activity in tramway and railway material, users limiting the requirements to little more than the bare maintenance of systems. For the same reason material for rolling stock is not being asked for, except on a very modest scale, though repairs to the necessary replacements of railway wagons call for a fair proportion of what bar iron is available. On this iron, too, there is a demand for the making of horseshoes. Crushers and similar machinery for gold and other mines are in urgent request, principally for African and Australian mines. South America and some of the Colonies are placing orders here rather freely for manganese points and crossings for both tramways and railways. Russia continues a very large buyer of high-speed steel goods in the form of reamers, milling cutters, drills, &c. On the armament side there is great activity in the gunshops, particularly in the re-lining of guns. Rolling mills are extremely busy, and preparations are being made in some directions for important extensions. The absorption of smaller firms continues, the latest instance being the acquisition by a large steel company of a concern manufacturing as principal lines railway buffers and springs and high-speed steel, whilst at the close of the war developments in wheel and axle works, on a considerable scale, may be looked for at Rotherham at which place, too, I hear that some new steel furnaces have now been got to work. War conditions are limiting the multiplication of electric furnaces, except strictly for munitions purposes, but new large gas furnaces for annealing work are being installed here and there, town's gas being consumed. Recent overseas business includes files for Tangier, Maranham, Buenos Aires, Alexandria, Rosario, Madras, Rangoon, Lisbon, Sao Pedro, and Sekondi; steel for Rangoon, Torina, Milan, Havana, Montreal, and Sao Pedro; tools for Bombay, Bilbao, Maranham, Rangoon, Genoa, Port Swettenham, Penang, Rio, Cartagena, Montreal, Singapore, Hong-Kong, and Buenos Aires; cutlery for Puerto Cabello, Savanilla, Rosario, Santos, Demerara, and Calcutta; sheep shears for Buenos Aires, and saws for La Libertad.

Iron, Steel, and Coal.

In consequence of the approaching suspension of work over the holidays, business in iron tailed off early in the week, though it is not anticipated that the resumption of operations will find much change in the market. With practically all prices fixed, and supplies none too free in any direction, there is little room for fluctuation, though a tendency to "bear" the market is said to have been observable so far as Derbyshire makes are concerned. The belief is revived that sufficient extra ore supplies will soon be forthcoming, and the necessary labour to enable more furnaces to be lighted in the hematite districts. In the meantime, consumers are receiving very fair deliveries, though not for private contracts. As indicated above, the output of local acid steel has been augmented by the production of more new furnaces. Steam coals keep strong and active, the output having lately been interfered with by the "wakes" holidays in colliery districts; but wherever possible manufacturers are endeavouring to get extra stocks on the ground in anticipation of any adverse change through the new "control" arrangements next month. The Government takes a large proportion of the coal sent to the coast, and the remainder is divided between France and Italy, neutrals now securing very little. Nuts are in full demand, but slacks show no marked change. The call for house coals is fully as strong as ever. Best South Yorkshire steam hards quote 17s. 9d. to 18s.; best Derbyshire hards, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 17s.; nuts, 16s. 6d. to 17s. 6d.; best hard slacks, 12s. 6d. to 13s.; seconds, 12s. to 12s. 6d.; soft nutty slacks, 12s. to 12s. 3d.; pea slacks, 10s. 6d. to 11s.; and small slacks, 6s. to 7s. In house sorts branch quotations are 21s. 6d. to 22s. 6d., and best Silkstone is 18s. 6d. to 19s. 6d. per ton at pit.

SCOTLAND.

(From our own Correspondent.)

Full Resumption.

All branches of industry are once again operating at full strength. The concluding portion of the year promises to be even more intensely active than the preceding months, the maximum effort being devoted to war requirements. Works, however, are now better equipped for the strain, and the flow of the necessary materials should now be of sufficient bulk and regularity. The labour situation is still a complex one, but no doubt solutions will be speedily found for all such problems, and thereby allow of complete concentration on the work on hand.

Pig Iron.

Conditions in the pig iron trade show little alteration. Some brands are becoming very scarce, especially No. 1 foundry, which is not always obtainable. Hematite continues in particularly strong demand at the steel works. The call for forge iron, too, is steadily maintained. Prices are all firm.

Quotations.

Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglington, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

Activity at the Scotch steel and ironworks is once again in full swing. At the steel works it is increasingly evident that practically nothing outside of war requirements, or closely associated therewith, will have any chance of completion. High quality steel is now very precious, and all efforts are being made to conserve every particle of the output for military and naval purposes. Makers of black sheets have an abundance of orders for the heavier gauges, but, unfortunately, the production is still retarded by a scarcity of raw materials. At the malleable ironworks the facilities for production have been greatly increased, but it is not anticipated that the quantities available for ordinary distribution will be materially increased. In all branches of the engineering trade, and especially the machine tool department, good orders abound, and the recent advance in wages will mean an increase in values. Work on hand at the shipyards is making satisfactory progress. The export department generally is very dull, and no change can be looked for under present conditions.

Coal.

Employment in the Scotch coal trade is now pretty much as it was prior to the stoppage for the holidays. Conditions, too, show little alteration, markets being still very depressed, with a general lack of steadiness. In the West of Scotland district the industrial outlet is still large, but otherwise business is slack. Prices continue as last week's level. Best ells are quoted f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigations, 25s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. The situation in the Lothians is most unsatisfactory. In this district practically nothing is being done in the export department, and with local requirements of a light nature a great deal of idle time is being experienced. First-class steam coal is quoted f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The position in Fifeshire is also very poor, business both on home and export account being very meagre, and the miners are only getting about three full days' work in a week. First-class screened navigation coals are quoted, f.o.b. at Methil and Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s. per ton. The aggregate shipments from Scottish ports during the past week amounted to 125,825 tons, compared with 157,086 in the preceding week, and 215,510 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Strike Troubles.

Since writing a week ago strike troubles in the coalfield have monopolised a larger share of attention, probably, than other questions. Until recently South Wales has enjoyed a fairly long spell of freedom from drastic measures on the part of labour, but during the past two or three weeks resort to suspension of work, though spasmodic in character, has become rather too frequent and menacing to be regarded with indifference. In this district, at any rate, strikes appear to be more infectious than in other areas. Miners at Ebbw Vale and Tredegar, numbering about 12,000, were idle for about a week; but, fortunately, agreement was come to on Tuesday that the men should return to work. There was very grave danger that, unless something satisfactory and prompt was done, men at neighbouring collieries would have come out in support of those actually on strike, and there was no saying where things might end. The Home-office evidently realised this, and the probability is that the opinion was also formed that there was some justification in the men's complaint that their grievances are not dealt with as rapidly as might be the case, as it is significant that Sir Richard Redmayne, the Chief Inspector of Mines, who visited Cardiff on Tuesday, heard the representatives of the parties concerned in the dispute and secured a settlement without reference to the Conciliation Board, the Joint Emergency Committee of which had a meeting the same day.

Dry Dock Wages.

The Committee on Production has given its award concerning applications for advances in wages made to the Engineers' and Shipbuilding Employers' Association (Cardiff, Newport, Barry, and Penarth districts), and the Cardiff and District Master Iron Founders' Association, by about a dozen trade unions, including the Amalgamated Society of Engineers, the Dock, Wharf, Riverside, and General Workers' Union, the National Amalgamated Labourers' Union, &c. Evidence by the parties was heard on July 19th, and the decision of the committee is that men of 18 years and over should get an increase of 3s. per full ordinary week as from August 1st, boys and apprentices under 18 years to receive 1s. 6d. per full ordinary week as from the same day. These amounts are over and above the advances given by the committee in its award of March 22nd. The amount conceded is considerably less than the demands put in by the men.

Pilots' Application Fails.

The Port Talbot Chamber of Commerce and the Cardiff and Bristol Channel Shipowners' Association have been notified by the Board of Trade that, with regard to the application of the Dock, Wharf, Riverside and General Workers' Union on behalf of the pilots at Port Talbot for a by-law to be made authorising an increase of the pilotage rates at that port by 25 per cent. by way of war bonus, the Board is unable to find that sufficient justification exists in the present circumstances to require the Port Talbot Pilotage Board to make the by-law asked for.

Water Scheme.

The Newport Waterworks Committee has decided to recommend the Town Council to proceed with the Talybont and Merthyr water scheme at an estimated pre-war cost of £600,000. It was pointed out at the meeting of the committee that Merthyr could only guarantee the maximum of four million gallons daily two years after the war, whereas Newport's present consumption is three million gallons daily, and it is estimated that ten years hence the daily consumption will be ten million gallons.

Current Business.

New business in the coal trade during the past week has been on a minimum scale. Time lost at the collieries has been considerable, and the loss of output has, as a consequence, been very substantial. During the past few days, however, the position of many of the collieries producing the better quality coals has improved, and it is probable that in view of the three days' holiday in the coalfield next week, supplies of Admiralty descriptions will not be any too plentiful. The Coal Controller urged that the men should confine their holiday to two days, but the miners' leaders replied that the men had decided on three days, and, therefore, the owners agreed to the miners' request. Work at collieries producing lower grade coals is still very unsatisfactory, as, of course, they are not assisted in the matter of tonnage as are the better coals. Nuts and beans have been in good demand. Owing to the stoppage of work at the Ebbw Vale and Tredegar collieries the inquiry for coke has improved considerably, with the result that stocks of this commodity have been very substantially reduced. Patent fuel continues very steady at about 30s., but pitwood is on the easy side at 58s. to 60s., importers being still at a disadvantage owing to the difficulties regarding empty wagons.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d.; patent fuel, 30s. Coke, 47s. 6d. Pitwood, ex ship, 58s. to 60s.

Newport.

Operations have been on quite a trifling scale, and shipments have been confined practically to coals on contract. The tonnage position has slightly improved, with the result that more tips are working at the docks than was the case last week. Supplies of coal coming down to the port were affected by the strike at the Tredegar and Ebbw Vale collieries, though at the same time it has enabled stocks to be worked off, and has relieved the congestion in the matter of loaded wagons. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 28s. 6d. to 30s.; pitwood, ex-ship, 58s. to 60s.

Swansea.

The market generally continues on the quiet side. The majority of collieries are only working half time, but stocks of large anthracite are heavy. Machine-made qualities are firm, and supplies of beans and peas are not up to requirements, so that inland orders are delayed in being met. Patent fuel works are also engaged on about half time. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine-made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 10s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, 25s.; smalls, 19s. Bituminous coal: Through and through, 27s.; smalls, 24s. Patent fuel, 28s. to 30s.

IRRIGATION FOR VEGETABLE GROWING.

A development of irrigation which is applicable in regions of moderate rainfall is the use of water for periodical sprinkling of vegetables and similar crops. Rains are not uniform, and lack of rain at certain times may cause injury or loss to the crop. With fields and vegetable gardens properly equipped, and with water obtainable at suitable rates, the uncertainty of crops may be greatly minimised, and the total production increased materially. For orchards and certain crops the water may be conveyed in underground pipes. For vegetable gardens a system of overhead perforated pipes may be used, spraying the water in the similitude of rain. To promote this development, its advantage as giving an increased field for city and private water-supply departments is being given publicly. At Bridgeton, U.S.A., near the Atlantic Coast, the municipal water department is supplying water for irrigating a score of gardens of half an acre to an acre, besides a dozen smaller gardens requiring 100 to 200 lineal feet of overhead pipe. Near this city a market-garden company has 100 acres irrigated by means of its own water supply system. The productivity is greatly increased, and in many cases two crops can be grown in a season where ordinarily only one crop is obtainable. The system is available for the small farmer or gardener as well as for the larger farms or gardens. It is as yet in its infancy, but is growing, and will receive a stimulus from the present conditions which demand special attention to the increase of food production.

THE UTILISATION OF PEAT.

THE Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a Committee of Inquiry into the utilisation of Irish peat deposits.

The terms of reference to the Committee are as follows :—"To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which, in the most favourably situated localities, it can be profitably won, prepared, and used, having regard to the economic conditions of Ireland, and to report to the Fuel Research Board."

Though the inquiries of the Committee will ultimately lead up to the consideration of peat as a source of energy in central power stations, there are sound reasons why this aspect of the problem should be postponed to a later stage. On the one hand, the Fuel Research Board is already organising an extensive inquiry into the problems of fuel economy in connection with power production, and the results of this inquiry will supply the fundamental data and information which will be required when the time comes for the consideration of any wide scheme of development in Ireland. On the other hand, any schemes of development must be based on a more exact knowledge than is at present available regarding the selection of the more favourably situated bogs and the possibilities of winning and transporting partially dried peat to centres at which it may be converted into marketable products. It is obvious, therefore, that the inquiries of the Committee are likely to be most fruitful if they are concentrated on the fundamental problems, for until these are settled no satisfactory progress can be made.

The following appointments have been made to the Committee :—Sir John Purser Griffith, M.A., I.M. Inst. C.E., Chairman, Rathmines Castle, Rathmines, Dublin ; Professor Hugh Ryan, M.A., D.Sc., F.I.C., University College, Dublin ; Professor Sydney Young, D.Sc., F.R.S., Trinity College, Dublin ; Mr. George Fletcher, Department of Agriculture and Technical Instruction for Ireland, Upper Merrion-street, Dublin ; Professor Pierce Purcell, M.A., M.A.I., Assoc. M. Inst. C.E., Secretary, University College, Dublin. All communications should be addressed to :—The Secretary, The Peat Inquiry Committee, University College, Dublin.

CATALOGUES.

THE WESTINGHOUSE COOPER HEWITT COMPANY, Limited, 80, York-road, King's Cross, London.—List No. 75B. Illustrated pamphlet dealing with mercury vapour converters for transforming alternating current.

R. WHITE AND SONS, Widnes.—Illustrated booklet showing a selection of the firm's products, including light railways complete with sleepers : side or end tip wagons, railway points and crossings for either standard or light railways, aerial ropeways, &c.

LA SOCIETE GENEVOISE D'INSTRUMENTS DE PHYSIQUE, 8, Rue des Vieux, Grenadiers, Geneva, Switzerland.—Illustrative descriptive catalogue in French, dealing with various high precision tools, including measuring machines for length, diameter, screw threads, &c., special micrometers, dividing machines of various types and for various purposes, a special screwing lathe, and gauges of numerous types.

BRITISH INSULATED AND HELSBY CABLES, Limited, Prescot, Lancashire.—The Prescot wiring system to which this publication is devoted is not a new invention. It consists in the use of twin-house wiring, in conjunction with joint boxes, ceiling roses, switch and plug bases, and iron-clad distribution boxes. A special feature of the system is its great flexibility, which permits the laying of the wires in positions where it would be difficult to put casing or tubing. The wire is intended for pressures up to 300 volts.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Limited, Trafford Park, Manchester.—Two uniform catalogues from the above firm deal with the Westinghouse Diesel engine and turbo-alternators. The former are of the vertical single-acting type operating on the four-stroke cycle. Illustrations are given of four-crank four-cylinder, three-crank three-cylinder, and six-crank six-cylinder engines, as well as the essential details. The turbo-alternator catalogue contains numerous excellent illustrations of machines of this class erected in power stations in this country and abroad, together with illustrations showing the method of construction, ventilation, &c. Both books are extremely well printed, and the engravings are of the highest class.

NATIONAL ASSOCIATION OF INDUSTRIAL CHEMISTS.—The provisional executive appointed by representative chemists employed in Sheffield and district has been for some weeks considering the basis, rules and constitutions for the proposed National Association of Industrial Chemists. Its conclusions will shortly be published in book form. About one hundred chemists have already been declared full members. All communications should be addressed to the Propaganda Committee, Bailey-street School-rooms, Sheffield.

THE RESOURCES AND PRODUCTION OF IRON AND OTHER METALLIFEROUS ORES.—In order to meet what has apparently been a want, both to those actually engaged in the iron and steel industry as well as to those who are interested in obtaining knowledge of the mineral resources on which the industry mainly depends, the Advisory Council for Scientific and Industrial Research has thought it desirable that a report should be compiled summarising the latest information available regarding the iron ore resources of the United Kingdom, as well as those of other countries. Although a vast amount of information has been published from time to time, it exists mostly in the form of reports and monographs scattered throughout the *Proceedings* of technical and scientific societies, and in the very valuable publications of the Geological Surveys and Mines Departments of this country, and of the principal Dominions of the British Empire, also in those of other countries, particularly the United States. Consequently much time and labour has to be spent in searching for the literature on the subject. The aim of the report therefore has been to collect and present in a summarised form the main facts concerning the resources of iron ores and of other metalliferous ores accessory to the metallurgy of iron and steel, and to indicate their composition and character, giving as many analyses as possible of the minerals in every locality, with indications as to their geographical position and accessibility. The report has been prepared by Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, and is to be obtained through booksellers. The price is 2s. net.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application ; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

107,316 (14,086 of 1916). October 4th, 1916. SUPERHEATER. Percy St. George Kirke, Parliament Mansions, Victoria-street, Westminster.

Steam superheating arrangements in accordance with this invention comprise boiler tubes, each packed for a portion of their length with packing material A, in contact with, or in the neighbourhood of which combustion of the gaseous fuel may take place, superheating coils B arranged within another portion of each of the tubes, and further packing material C in the remainder of the tubes so as to reduce the temperature of the gases and combustion products to a few degrees above that of the saturated steam. The accompanying drawings illustrate a gas-fired steam boiler of the kind referred

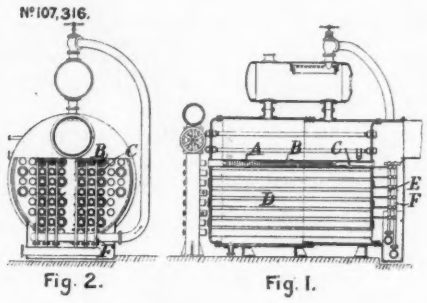
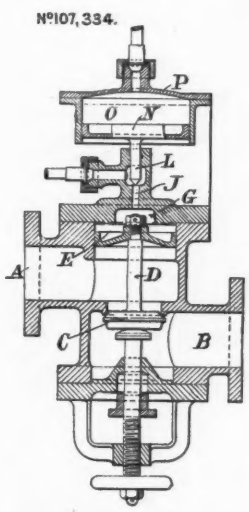


Fig. 2. Fig. 1.

to provided with superheating arrangements. Fig. 1 is a longitudinal sectional view ; and Fig. 2 is an end elevation. The superheater coils B extend backward and forward of the tubes D, and each coil is connected at one end to a header E in connection with the source of saturated steam, and at the other end to a header F in connection with the steam engine. The packing material C is shown pointed against the direction of the flow of the gases, so that any dust contained in the gases may pass out of the end of the tubes D.—*June 28th*, 1917.

107,334 (16,874 of 1916). November 24th, 1916.—SAFETY DEVICE FOR OIL-FIRED BOILERS, Harold Edgar Yarrow, Scotstoun, Glasgow.

In order to prevent the passage of flame from the furnaces of an oil-fired boiler to the stokehold of a ship, this invention provides a piston or diaphragm, the surfaces of which are exposed respectively to the atmosphere and to the air pressure existing in the stokehold by which the supply of oil fuel is automatically shut off if the pressure of the air supply to the furnaces is reduced by a given amount. The apparatus is shown in section. A being the air inlet to, and B the outlet from, a passage controlled by the valve C which regulates all the oil fuel supplying the boilers. C is connected by a spindle D to the piston E, and the latter has a small hole to allow the oil to by-pass into

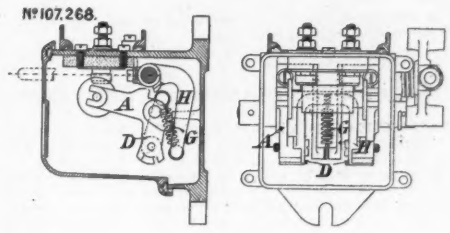


the space G. The area of the piston E is greater than that of the valve C, so that should an outlet be opened for the oil in the space G, the piston E will be raised by the oil pressure on its lower surface and close the valve C. The space G is connected with a narrow passage J closed by a needle valve L connected to a piston N movable in a cylinder O, which is open below but closed above by a cover P. The cover is in connection by a tube with the compartment under air pressure, and as long as the upper surface of the piston N is exposed to this pressure the needle valve L closes the passage J, and the valve C is kept open by the oil pressure. Should the air pressure be largely reduced, the piston N is raised by the oil pressure acting on the needle valve J which is thereby opened, and the pressure being relieved from the top of E the latter rises and closes C.—*June 28th*, 1917.

SWITCHGEAR.

107,268 (9646 of 1916). July 8th, 1916.—QUICK MAKE AND BREAK SWITCH, George Ellison and James Anderson, Victoria Works, Warstone-lane, Birmingham.

In the switch constructed according to this invention three relatively movable levers A, D, H are employed, one pivoted at one end and attached to the operating handle or its equivalent, another in the form of a bell-crank lever carrying a movable contact, and a third or intermediate lever pivoted with provision for a certain amount of free movement on the end of the contact lever opposite to the movable contact and connected to one end of the handle lever by a spring. The arrangement

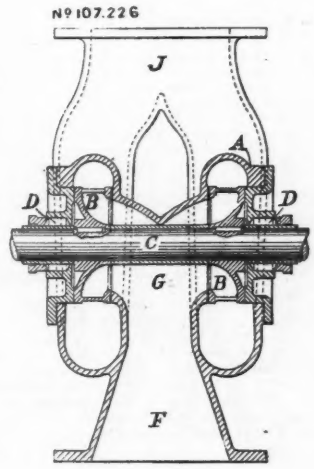


of the parts is such that during the opening movement of the switch the spring G maintains a definite pressure on the contacts until after it has been moved through its dead centre position relatively to the intermediate lever.—*June 28th*, 1917.

PUMPING AND BLOWING MACHINERY.

107,226 (8525 of 1916). June 16th, 1916.—CENTRIFUGAL PUMPS, J. Stone and Company, Limited, Deptford, and another.

This invention provides for obtaining the combined effects of balance of the pump, and delivery pressure on the glands in pumps of the plain centrifugal type, by arranging the impellers so that the reactions in the direction of the axis of the shaft are equal and opposite, whereby the pump, in all circumstances and under all conditions, works in perfect hydraulic balance, and so that delivery of the impellers is on the glands and the suction remote from the glands, whereby the latter are hydraulically sealed by the liquid in the pumps. A is the pump casing containing impellers B mounted on a shaft C which passes

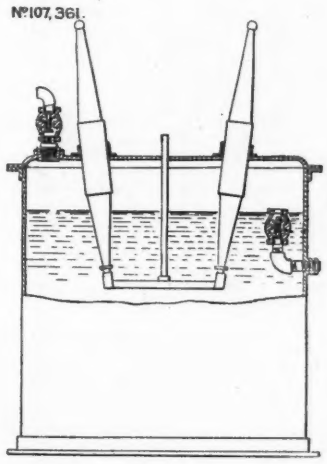


through glands D. The suction inlet F leads into a suction chamber G arranged between the impellers B and shaped so as to direct the water to the respective sides and into the respective impellers B. The delivery chambers of the two impeller casings are suitably joined into one delivery connection J. The impeller casings are joined to the suction chamber G and connection F. The bearings and glands D of the pump are on the outer walls of the impeller casings, and are thus subjected to whatever may be the pressure of the delivery of the pump. In any case they are never subjected to suction. The side openings are covered by plates formed with suitable annular faces.—*June 18th*, 1917.

TRANSMISSION OF POWER.

107,361 (4946 of 1917). April 5th, 1917.—CIRCUIT INTERRUPTERS, British Westinghouse Electric and Manufacturing Company, Limited, 2, Norfolk-street, Strand, London.

Hitherto it has been customary to protect the oil-containing receptacle of a circuit interrupter by the use of a baffled vent that permitted circulation of air in the receptacle under normal conditions and which tended to prevent the expulsion of the



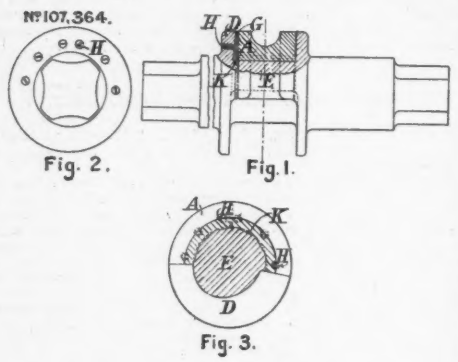
oil when the pressure increased. However, irrespective of the baffle plates in the air vent, oil was occasionally forced from the receptacle upon the opening of the circuit interrupter, and because of the position of the baffled bent, only relatively light gases were permitted to escape from the receptacle under normal conditions. In the device, according to the present invention, one or more vents is or are provided with spring-actuated valves

that normally hold the vents open, but which, upon an increase in internal pressure, cause the vents to be closed to preclude the expulsion of the oil. The vents are so disposed that gases which are heavier or lighter than the air may freely pass from the receptacle under normal conditions. The accompanying drawing shows, in section, a circuit interrupter that is provided with automatic ventilation controlling means embodying the invention.—*June 28th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

107,364 (6912 of 1917). May 15th, 1917.—Rolls for Rolling Mills, Frederick Charles Fairholme, Norfolk Works, Savile-street, Sheffield, and another.

In pilger or step by step rolls for rolling hollow steel blooms the inventor makes the rolls with a renewable or interchangeable working face or fillet of hard steel secured upon the barrel and between two upstanding collars of a roll of mild steel. The arrangement is shown in Figs. 1—3. In fitting the several

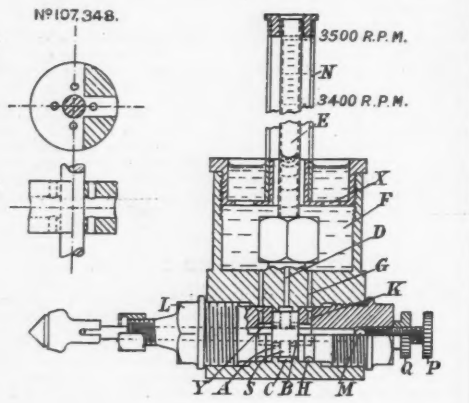


parts together the fillet A is first placed on the barrel E, and the washer G is then slid into position over the circular portion K of the barrel by a circumferential movement until it makes close and firm contact with the face of the collar D and the end of the fillet A. The wedging action of this washer is sufficient in itself to hold the various parts in place; but as an additional security grub screws H are inserted through tapped holes in the flange D, the ends of which bear against one side of the washer G, which may if desired have small countersunk recesses to receive them.—*June 28th*, 1917.

MEASURING AND TESTING INSTRUMENTS.

107,348 (552 of 1917). January 11th, 1917.—Liquid Speed Indicator, William Alexander, 1, Broomhill-avenue, Whiteinch, Glasgow.

This instrument shows the speed of rotating pieces of machinery by means of a hydrostatic head due to a forced vortex in a liquid, the vortex being formed by a rotary impeller A. The impeller is rigidly connected to the driving spindle B which is driven by the shaft the speed of which is required. A circumferential passage C surrounds the impeller, and this passage communicates through a passage D with a graduated transparent stand tube E up which the liquid is forced to a height depending on the speed. The graduations may represent revolutions per

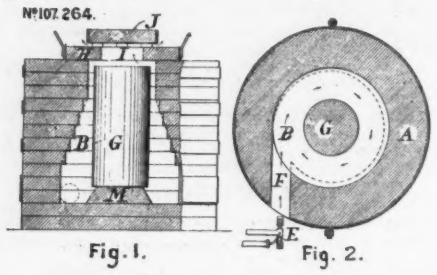


minute of a rotating piece or miles per hour of a road vehicle. A reservoir F, forming an integral part of the instrument, surrounds the lower end of the stand tube, and communicates with the annular inlet spaces Y, in the plugs L, through holes G, annular spaces H, and holes K in the plugs. A standard N gives lateral support to the stand tube and is fixed at its lower end to the screwed cover of the reservoir. The cover acts as a filler for the reservoir, and is provided with openings X allowing of liquid passing from the cover into the reservoir. To take up thrust on the shaft, and to adjust the axial position of the impeller, an adjustable thrust bearing M is provided which is adjusted by means of the screw P and lock-nut Q.—*June 28th*, 1917.

LIGHTING AND HEATING.

107,264 (9545 of 1916). July 6th, 1916.—Billet Furnace, Harold Newsom Davis and another, Diamond Foundry, Luton, Bedford.

This invention refers to oil and gas-fired furnaces in which the combustion chamber is bounded by upstanding walls tapering towards their upper end. The combustible mixture from the burner E is fed into the combustion chamber through a tangential opening F at the base of the furnace. The billets or ingots G to be heated are arranged on a suitable support M above the floor level, so as to leave a space between them and the inner wall of the combustion chamber. This construction of the walls causes the products of combustion in rising to be forced inwards towards the billet as they rise, and until they escape from the upper end of the combustion chamber B through the relatively narrow annulus left between the billet G and the upper end of the chamber. In order to increase the efficiency of the furnace, the latter has a removable upper fire-brick cover plate H which partially closes the upper end except for a central aperture I, and over this aperture is a baffle J also of fire-brick, which has a reverberatory effect upon the upper end of the billet. In the construction of furnace hereinbefore described, the combustion chamber is preferably circular in

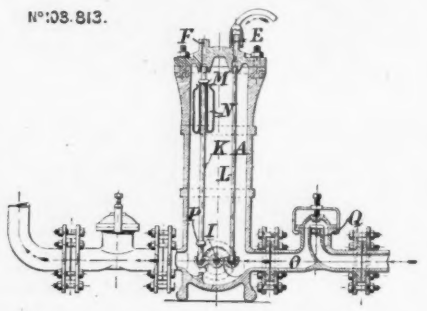


cross section and concentrically disposed in relation to the central billet, but if desired it could be arranged excentrically, as shown by the dotted line in Fig. 2.—*June 28th*, 1917.

MISCELLANEOUS.

103,813 (15,467 of 1916). October 30th, 1916.—Apparatus for Raising Liquids, Joseph Catelle, 12 Quai de Cuire, Caluire-Cuire (Rhone), France.

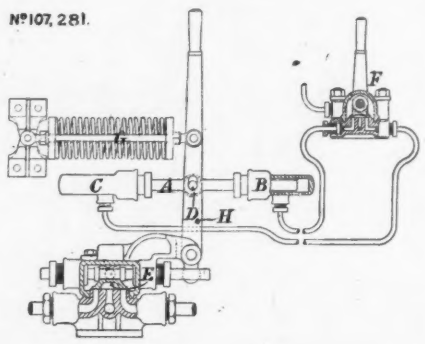
This apparatus is operated by compressed air, the mechanism for admitting, retaining, and expelling the air being operated by the change of level. The appliance illustrated is intended for raising acids, and the cylindrical receptacle is made of stoneware. The liquid to be raised enters on the right-hand side, as shown by the arrows, and leaves on the left-hand side, the compressed air entering by the pipe E shown on top. The action of the apparatus is briefly as follows:—The liquid to be raised is placed in a container placed above the apparatus, and is brought into action by opening the discharge cock. At this moment the orifice E of the receptacle A is closed and F is open. The



liquid from the container lifts the admission valve Q and passes into the receptacle through the passage O; the air escapes through the opening F, the float N rises with the liquid whilst sliding on the rod K until it meets the upper shoulder M and lifts this rod, thus assuring the closure of the orifice F. The weight of the rod L has become preponderant on the balance I, and the compressed air re-enters through the orifice E driving back the liquid contained in the apparatus; the float N descends again, but the rod K remains suspended by the pressure of the compressed air until the float meets the lower collar P of K, causing it to fall. At this moment the weight of K becomes preponderant on L, the orifice E closes and F is open, and a new cycle commences.—*June 28th*, 1917.

107,281 (10,597 of 1916). July 27th, 1916.—Controlling Gear for Hydraulic Lifts, Brown Brothers and Co., Limited, Rosebank Ironworks, Edinburgh, and another.

The apparatus illustrated comprises briefly a double-ended ram A operating in the two opposed cylinders B, C, as in certain closed circuit telemotor apparatus. The ram is pivotally connected at D to a hand lever H operating either the main



valve E of the lift, or a relay valve controlling the main valve. The ram cylinders are connected by pipes with a hand-operated slide valve F at the central station, this valve controlling the admission and discharge of pressure fluid from an extraneous source to and from the cylinders. The spring device G is connected to the hand lever H so as to bring the latter back to the central position when free.—*June 28th*, 1917.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are asked to announce that the Board of J. Samuel White and Co., Limited, of Cowes, has been augmented by the appointment of Sir James B. Marshall, K.C.B., as deputy chairman.

Mr. A. P. Trotter has arranged to enter into partnership with Messrs. Handcock and Dykes, consulting engineers. The partnership will take effect on the 1st October, 1917, from which date the name of the firm will be Handcock, Dykes and Trotter, the address being 11, Victoria-street, Westminster, S.W. 1, as at present.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for The Engineer *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of six of the patents given below £26 *and on each of the remainder* £18 *have been paid in renewal fees.*

No. 20,634/10.—Electric coils, &c. Coils, in which the insulation depends on a film of oxide or other salt formed on the surface of the wire, are mechanically protected by impregnating with a liquid such as pitch thinned with turpentine lac, which subsequently hardens. Specialfabrik für Aluminium Spulen und-Leitungen Ges., Berlin. Dated September 4th, 1909.

No. 20,681/10.—Counting apparatus; transfer mechanism. In arrangements of the externally operated kind, adapted to transfer for either direction of rotation, two transfer actuating teeth are provided upon a plate which can slide and partly rotate under the action of springs and of a restoring member, the plate being tripped for movement when the transfer tooth upon the lower wheel reaches the transfer point. Wolter, C., Berlin.

No. 20,794/10.—Purifying and cooling gases. A method of purifying and cooling gas consists in treating the gas first in a disintegrator with water and subsequently in a fan, the hot dust-laden gases being led from the periphery of the disintegrator towards the centre in a radial direction, and in a counter current to the washing water between two sets of disintegrating pins or rods, carried by discs, which are rotated in opposite directions to each other, the gases being then sucked off by the fan and freed from any water mist by centrifugal action. Bayer, C., Prussia. Dated September 23rd, 1909.

No. 21,130/10.—Floors. In a floor of the type consisting of glass blocks or slabs and concrete ribs, the blocks are formed with spacing projections, preferably as flanges, which abut, and above which are applied the concrete filling and reinforcement. The joint may be formed with a groove, or it may be concealed by a moulding formed on the blocks. Keppler, F. L., Berlin. Dated November 20th, 1909.

No. 21,240/10.—Electric meters; induction motor meters; power meters. The shunt magnet for an energy meter or power meter has a magnetic shunt, parallel with the disc and a pole arranged so that the useful field cutting the disc is widely spread and may, therefore, be weak. Strelow, M., Berlin. Dated September 10th, 1909.

No. 21,335/10.—Cable conveyors. In cable conveyors used for transhipping at sea, in which the cable is slipped under excessive strain, the slipping pulley is mounted to move against a suitable resistance, so as to allow sufficient time and clearance for normal conditions to be restored, if possible, prior to the slipping of the cable. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges., Germany. Dated October 30th, 1909.

No. 21,472/10.—Drying. Potatoes, cattle foods, and other materials forming a crust on drying, are dried in an apparatus consisting of a perforated drum through which hot air is introduced, and carrying external stirring blades, and a set of rotary blades passing between the stirring blades and scraping the surface of the drum. The perforated drum, into which hot air is introduced through the hollow trunnion, rotates in a trough and carries blades. The scrapers are, preferably, made of a helical form to move the material from the inlet towards the outlet. Weiss, C., Germany.

No. 21,750/10.—Horn substitutes. Air-dried casein is mixed with as small a quantity of water as possible, kneaded under high pressure and heat, and pressed into shape to form a horn substitute. Bartels, A., Germany.

No. 21,793/10.—Ammunition; projectile fuses. Relates to fuses provided with a hollow screw-threaded plug for attaching the fuse to the projectile, and a cover-plate made separate from the plug and forming a percussion chamber for the fuse. Krupp Akt.-Ges., F., Germany. Dated December 20th, 1909.

FORTHCOMING ENGAGEMENT.

SATURDAY, AUGUST 4TH.

The North of England Institute of Mining and Mechanical Engineers.—Wood Memorial Hall, Newcastle-upon-Tyne. Annual general meeting. The following papers will be open for discussion:—"Further Notes on Safety Lamps," by Mr. Simon Tate; "Some Practical Notes on the Use of Timber in Coal Mines," by Mr. F. C. Lee; "The Horsley and Nicholson Automatic Compound Syphon," by Mr. George R. Nicholson; the following paper will be read or taken as read:—"Little Namaqualand and its Possibilities as a Copper Producing Country," by Mr. F. W. Jenkins. 2 p.m.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters:—Balderton-street, Oxford-street, W.

ORDERS.

For the week, by Lieut.-Col. C. B. Clay, V.D., Commanding.

Extract from the Gazette.—County of London Volunteer Engineers, E. A. Ullman to be Temp. Second Lieutenant.

Resignation.—Company Commander E. J. Castell resigns his appointment on obtaining a commission in the R.N.A.S.

Saturday, August 4th, to Sunday, August 12th.—Camp at Esher.—During this period the Headquarters at Balderton-street will be closed and will be removed to the Headquarters at the Camp, Claremont Park, Esher.

Musketry.—The range at Belvedere-road will be open on Tuesday, Wednesday and Thursday, the 7th, 8th and 9th August respectively from 5.30 to 7.

Armlets.—The new issue armlets can now be obtained at Headquarters, and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the orderly room.

By order,

Macleod Yearsley.
Company Commander and Adjutant.

August 4th, 1917.

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VOL. CXXIV.—No. 3215] LONDON: FRIDAY EVENING, AUGUST 10, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

The Ministry of Munitions

HAS FOR DISPOSAL

CAST IRON CIRCULAR TANKS,

WITH HEATING COILS INSIDE,

as follows:—

Four 20ft. diam. × 22ft. deep.
One 21ft. 6in. diam. × 22ft. deep.
Two 19ft. diam. × 15ft. 6in. deep.

Working pressure 21b. per sq. inch.

For further particulars apply:—

MINISTRY OF MUNITIONS,
74/Sales/111,
Storey's-gate,
393 Westminster, S.W. 1.

The Proprietor of Letters Patent

No. 18,830/13, relating to
"INTERNAL COMBUSTION ENGINES"
DESIRES to DISPOSE of the PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the Patent in this country.
Inquiries to be addressed to
CRUIKSHANK and FAIRWEATHER, Limited,
65-66, Chancery-lane, London, W.C. 2. 404 B

The Proprietor of Letters Patent

No 28,753/10, relating to
"VAPORISERS for INTERNAL COMBUSTION ENGINES"
DESIRES to DISPOSE of the PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the Patent in this country.
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UNIVERSITY OF DURHAM.

Armstrong College, Newcastle-upon-Tyne.

PRINCIPAL: W. H. HADOW, M.A., D. Mus., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—
F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M. Inst.C.E., J.P.

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comprising
FACULTIES OF ENGINEERING AND METALLURGY.

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Civil Engineering	J. HUSBAND, B.Eng., A.M. Inst. C.E. (Lecturer).
Glass Technology	W. E. S. TURNER, D.Sc. (Lecturer).

The subjects in which courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes courses in Civil, Mechanical, Electrical and Chemical Engineering, and students specialise in one or other of these branches in the third year of their course. The course in Engineering extends over three years and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' courses are arranged for Works' Pupils, who come to the University from works in Sheffield, or from other centres, taking six months' study at the University and six months' practice at the works each year.

The DEPARTMENT OF METALLURGY includes (a) the Metallurgy of Iron and Steel, and (b) the Metallurgy of the Non-ferrous Metals. The course in Metallurgy ex ends over three years, and prepares for the Degree of Bachelor of Metallurgy (B.Met.) or for the Associateship of the University in Metallurgy. The equipment of this Department is on an exceptionally complete and practical scale

The work of the DEPARTMENT OF COAL MINING includes a three or four years' Diploma Course, consisting of six months at the University and six months at a Colliery.

The DEPARTMENT OF APPLIED CHEMISTRY deals specially with the subjects relating to various branches of Coal mining, and of the Coal and Coke Industries.

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The LECTURE COURSES of all the Departments are supplemented by Practical Training in Laboratories, Workshops, and Foundries fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part Time Courses are arranged for students who desire to take special portions of any of the regular courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917.

W. M. GIBBONS,
130 Registrar.

University of Manchester.

DEPARTMENT OF
ELECTRICAL ENGINEERING.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Full particulars of these Courses will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on the 4TH OCTOBER. 411

University of Birmingham.

PRINCIPAL:
SIR OLIVER LODGE, M.Sc., D.Sc., LL.D., F.R.S.

VICE-PRINCIPAL:
DR. R. S. HEATH, M.A.

ENGINEERING DEPARTMENTS.

I.—MECHANICAL ENGINEERING.

CHAIR PROFESSOR: F. W. BURSTALL, M.Sc., M.A. (Cantab), M. Inst. C.E., M. Inst. M.E.
LECTURER: R. C. PORTER, M.Sc. (Vict.), A.M. Inst. C.E.
DEMONSTRATOR: (Vacant).
LECTURER ON MACHINE DESIGN: F. J. BROSCOMB, M.Sc., A.M.I.M.E.
ASSISTANT LECTURER ON MACHINE DESIGN: W. G. WISHART, B.Sc.

II.—CIVIL ENGINEERING.

BEALE PROFESSOR: FREDERICK C. LEA, M.Sc., D.Sc. (Lond.), A.M.I.C.E., A.R.C.S.
LECTURER: W. NORMAN THOMAS, M.Sc., A.M.I.C.E., A.M.I.M.E.
ASSISTANT LECTURERS AND DEMONSTRATORS: ROBERT C. PANTON, M.Sc., M.A., B.A.I., and P. M. CHADWICK, M.Sc., A.C.G.I.

III.—ELECTRICAL ENGINEERING.

PROFESSOR: GISBERT KAPP, M.Sc., D.Eng., M. Inst. C.E., M. Inst. E.E.
LECTURERS: E. J. KIPPS, M.Sc., M. Inst. E.E., and THOMAS F. WALL, D.Sc. (Manch.), D.Eng. (L'pool), A.M. Inst. C.E., A.M. Inst. E.E.
ASSISTANT LECTURER AND DEMONSTRATOR: (Vacant).

THE FULL COURSES EXTEND OVER FOUR YEARS, and students who enter after matriculation and pass successfully the examinations at the end of each year will BE ENTITLED TO THE DEGREE OF BACHELOR OF SCIENCE in Engineering.

THE SESSION 1917-18 COMMENCES ON TUESDAY, OCTOBER 2ND, 1917.

For detailed Syllabus, with full particulars of University Regulations, Lecture and Laboratory Courses, Fees, Scholarships, &c., apply to the SECRETARY. 136

University of London, University College.

SESSION 1917-18.

FACULTY OF ENGINEERING.

THE SESSION BEGINS
ON MONDAY, OCTOBER 1ST.

DEGREE AND DIPLOMA COURSES.

Students desirous of entering the Faculty of Engineering with a view to taking a full Degree or Diploma Course must have passed the Matriculation Examination or some other examination accepted in its stead

SPECIAL COURSES.

Students who have already undergone a partial training elsewhere, and who have attained a sufficient standard, may enter for a course occupying less than three years, and may obtain a General Certificate of Engineering after not less than two consecutive sessions' attendances.

POST-GRADUATE WORK AND RESEARCH.

Graduates in Science or Engineering, or students who have done the work equivalent to a degree, may be admitted to Special Courses of Study, or to prosecute original research.

ENTRANCE SCHOLARSHIP.

A Goldsmid Entrance Scholarship, tenable in the Faculty of Engineering, value £90, will be competed for in September next. Application for entry forms must be made not later than September 11th.

ADMISSION.

Intending students should communicate with the Provost as soon as possible, and in any case not later than September 15th, and should send a full statement of their previous training.

Full particulars may be obtained on application to the undersigned.

WALTER W. SETON, M.A., D.Lit.,
Secretary,
University College, London
(Gower-street), W.C.
394

Oxford City Waterworks.

WASTE INSPECTOR.

WANTED, an INSPECTOR, with thorough knowledge of Water Fittings. Wages 33s per week

Applications, stating age and qualifications, with not more than three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Oxford, not later than Wednesday, the 15th of August instant.

Dated 1st August, 1917. 331

Wanted, Good Practical Man

to Take Charge of Small Works manufacturing Insulating Material. Must not be eligible for military service.—Address, 417, "The Engineer" Office. 417 A

Wanted, Foundry Manager for

large Engineering Works in Midlands, thoroughly experienced green, dry sand and loam. State age, experience and salary required. No one on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3500. 330 A

Works Manager. — A Really

capable Man with sound Engineering Training and Experience in Works Administration is REQUIRED to take CHARGE of a large Aeroplane Factory; London, N.W. Applicants need not necessarily have had previous experience in Aeronautical Engineering. No one engaged on Government work, or resident more than ten miles away, need apply.—Write, stating salary required, to 322, "The Engineer" Office. 322 A

Works Manager Required to

Take Charge of Government controlled works. Good opening for man of personality with previous successful experience in controlling men and having sound knowledge of modern Boiler Shop Practice. Commencing salary £200. Could take financial interest in company after proving satisfactory, if desired.—Address, 388, "The Engineer" Office. 388 A

Capable Working Engineer

WANTED to TAKE CHARGE of Heating Apparatus, Laundry, and other Machinery at Hospital; 130 beds, 80 soldiers. State full particulars, with recent testimonials and wages required.—Write, before August 20th, to SECRETARY, Warneford Hospital, Leamington. P682 A

Chiltern Hills Spring Water Co, AYLESBURY.

WANTED, skilled LABOURER for Repairing Mains, in Tring district, and to assist in repairs to deep-well pumps, cleaning out boilers and reservoirs; also work general to Pumping Station.

House, garden and coal provided at Dancers End Station.

Applicants must state wages required, together with age and qualifications.

P678 A H. A. CALLON, Manager.

Engineer-Surveyor, with First-

CLASS Board of Trade Certificate, WANTED by a leading Insurance Co. Applicants must be over military age or ineligible for naval or military service.—Address, giving age, experience, &c., to P885, "The Engineer" Office. P885 A

Engineers with Practical Experi-

ENCE of Design of Ferro-Concrete Structures REQUIRED by MOUCHEL and PARTNERS, Ltd., 38, Victoria-street, Westminster, S.W. 1.—Apply by letter, stating age, experience and salary required. P664 A

First-class Experienced Esti-

MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Rate Fixer Required for Tool

Room of Controlled Factory engaged on important Aero Engine work. Applicants must be thoroughly conversant with all kinds of machining and fitting required for Jigs, Tools and Gauges; Midland district. State age, experience and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 362. 362 A

Refrigerating Engineer Wanted

for abroad. First-class Board of Trade Certificate. Experience with Ammonia desirable. Must be over military age or ineligible for military service. No one engaged on Government work need apply.—Send application in, with copies of testimonials, giving details of experience, to T., Box 292, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 360 A

Resident Assistant Engineer

WANTED for Bethnal Green Military Hospital. Must be a first-class Fitter and Turner. Electric Light and Marine experience preferred. Must be ineligible for service. Wages 57s. 6d. per week, with board, lodging and washing.—Apply, giving full details of previous experience, testimonials, age, &c., to the CHIEF ENGINEER, Bethnal Green Military Hospital, Cambridge Heath, E. 2. 412 A

Wanted, Competent Cost Clerk

for large Government Controlled Engineering Works in Midlands, capable of taking charge. State previous experiences. No person already employed upon Government work will be engaged. Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P874. P874 A

Clerk, with Experience, to Assist

in Purchasing Dept. of Engineering Firm in Midlands, age about 25 years. No man already on Government work will be engaged.—Application, in first instance, should be made to your nearest Employment Exchange, stating experience and salary required, and mentioning "The Engineer" and No. A3523. 362 A

Cost Accountant, Thoroughly

experienced, for large controlled Engineering Works in Clyde area; good salary and prospects for first-class man. Only those with good record need apply. Give age and full particulars.—Address, ACCOUNTANT, Wm. Porteous and Co., Advertising Agents, Glasgow. P890 A

Wanted, Young Man as Junior

DRAUGHTSMAN for Engineering Works in Yorkshire; one with a knowledge of Steam Boiler Plant, &c. Give references, age, and salary expected. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 415. 415 A

Draughtsman (Junior) for Engi-

NEERS' Offices in Kingsway. Sufficient if had instruction at Technical Schools. State full particulars.—Address, 378, "The Engineer" Office. 378 A

Draughtsman, Junior, Mechan-

ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3254. 12 A

Draughtsman, Mechanical, One

used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 A

Draughtsman or Tracer Wanted,

ineligible for military service. State capabilities and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 376 376 A

Draughtsman (Permanent or

Otherwise), experienced, for Engineers' offices in Kingsway. State full particulars.—Address, 377, "The Engineer" Office. 377 A

Draughtsmen Wanted, Tho-

ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3495. 13 A

Wanted, Orders for

CONSTRUCTIONAL STEELWORK, TANKS, HOPPERS, ROOF TRUSSES, &c., HEAVY AND LIGHT PLATE WORK, by ENGINEERING FIRM in MIDLANDS.

Address, in first instance, P855, "The Engineer" Office. P855

Draughtsman Wanted, Mechani-

CAL or ELECTRICAL. Particularly with experience of Internal Combustion Engines or Aircraft.—Applicants must respond through the nearest Employment Exchange, stating age, experience, and salary required, mentioning "The Engineer" and number 384. No person at present on Government work will be engaged. 384 A

Draughtsmen. — One Leading

Man and One or Two Juniors WANTED for London office. Must have had first-class experience in Machine Tool or Forging Machinery work. Permanencies and excellent prospects for thoroughly capable men. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 397. 397 A

Leading Draughtsman Wanted,

with first-class experience in high-speed Internal Combustion Engine. A knowledge of Semi-Diesel would be an advantage.—Apply through nearest Employment Exchange, giving full particulars of experience, stating age and salary required. No person at present on Government work will be engaged. Mention "The Engineer" and number 383. 383 A

Assistant Foreman and Setter-

UP for Repetition Work on small Capstan Lathes worked by unskilled labour; brass and steel; works in Manchester. State age, wages required, and experience. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 372. 372 A

Foreman Electrician Wanted by

Engineering Works; must be used to high-tension wiring of all voltages and upkeep of plant, both alternating current and direct current. No person already on Government work will be engaged.—Apply, with references, to your nearest Employment Exchange, and mention "The Engineer" and No. A3542. 402 A

Representative: Steel Wire

ROPES.—Experienced and fully-qualified REPRESENTATIVE WANTED for South Wales Colliery District. Highest credentials required. Sound knowledge of the practical use of Wire Ropes and acquaintance with the District are desirable.—GEORGE CRADOCK and CO., Ltd., Wire Rope Works, Wakefield. 373 A

Steam Tractor (5-Ton Aveling

and PORTER).—WANTED, competent MAN, not eligible, as DRIVER for haulage of coal, farm produce and railway goods, &c.—Apply, BERRY and SONS, Oxted Station, Surrey. P885 A

Wanted, a Post of Responsi-

BILITY by a practical and theoretical engineer, capable of organising and taking charge on marine, general engineering, or war work. Three years' experience in charge of general engineering and war work (manufacture of various classes of shells and gun parts), with control of female labour.—Address, 399, "The Engineer" Office. 399 B

Works Manager (46) Shortly

OPEN for ENGAGEMENT. General engineering, marine, gun mountings; 12 years works management internal combustion engines; male and female labour.—Address, P888, "The Engineer" Office. P888 B

Works Trained Practical Engi-

NEER, who has for many years filled positions as Works Manager and Superintendent with good class firms, including three years' good experience in the production of Aircraft, R.A.F. and Private Designs, SEEKS POSITION of RESPONSIBILITY. A good organiser and thorough knowledge of works equipment.—Address, P876, "The Engineer" Office. P876 B

A Gentleman of Wide Experi-

ENCE (over military age) with the highest qualifications, DESIRES RESPONSIBLE POSITION in connection with the Design and Erection of Buildings or Engineering Works, or any Position of Trust, where ability, initiative, and energy are required.—Address, P881, "The Engineer" Office. P881 B

Chief Factory Engineer (44) is

OPEN to accept RESPONSIBLE POST. Has had over 25 years' practical, mechanical, and electrical engineering experience. Expert knowledge of confectionery, tea, cocoa and chocolate machinery. Sound technical education. Moderate salary for permanency.—Address, 422, "The Engineer" Office. 422 B

Constructional Engineer and

MANAGER, shortly to be disengaged, SEEKS APPOINTMENT; 10 years' experience on public works contracts; all branches of constructional work; used to dealing with large numbers of men and all kinds of contractor's machinery. Now employed constructing railways at one of H.M. munition factories (contract shortly terminating).—Address, 299, "The Engineer" Office. 299 B

Engineer-Buyer.—An Engineer,

with long works experience, is OPEN to INSPECT for PURCHASER, Test, Assemble and Dispatch Engineering Materials and Machinery for provincial or export house.—Address, 403, "The Engineer" Office. 403 B

Engineer, Mechanical (35), De-

SIRES CHANGE; 15 years at group of large collieries. Experienced in setting out, erection, and upkeep of modern mining plants. Well used to handling men. Good references.—Address, P883, "The Engineer" Office. P883 B

£5 Reward.—Lost, on 14th

July, 1917, a PARCEL containing two small Walnut wood Boxes, filled with Steel Block Gauges, marked C. E. Johansson Eskilstuna.—Particulars to C. P. and CO., 128, Goswell-road, London. P887 I

PARTNERS
DIRECTORS
BUSINESSES
FACTORIES
for these apply to
WHEATLEY KIRK, PRICE AND CO.,
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Albert-square, Manchester.
25, Collingwood-street, Newcastle-on-Tyne. Sp 3008

SMALL ADVERTISEMENTS

SITUATIONS, FOR SALE, &c.,

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PAGE LXXXIX.

Engineer (41), with Exceptional experience in the design and manufacture of AGRICULTURAL TRACTORS and COMMERCIAL VEHICLES, steam, petrol and paraffin, DESIRES responsible POSITION on War Work. Many years with leading firms, accustomed to handling men. Highest references.—Address, 401, "The Engineer" Office. 401 B

Mechanical Engineer, Belgian, no more eligible (wounded, and discharged) engaged since 18 months on munition work in France, WISHES to ENTER an English FACTORY, for family reasons. Fluent English, French and Dutch. Thorough knowledge of all mechanical work, works management, manufacturing organisation and production. Present salary £450.—Address, P679, "The Engineer" Office. P679 A

Plater, Practical, Working or Supervising, with large experience in all branches of Boilermaking and Iron Shipbuilding, including the framing and plating of damage jobs, deck stiffening, building of gun pedestals, and all kinds of dry dock and other repairs, is OPEN to TAKE JOB in London district.—Address, P691, "The Engineer" Office. P691 B

Russian Engineer (5 Languages), with high connections and references (now Artillery Inspector to the Russian Government in England), DESIRES POST as representative of British or American Firms in Russia.—Address, P835, "The Engineer" Office. P835 B

Young Engineer Requires Posi- TION as ASSISTANT MANAGER; good draughtsman, four years D.O., eight years shop; sound knowledge of filling and manufacture of fuses, grenades, bombs, &c., good experience on jigs and tools.—Address, P870, "The Engineer" Office. P870 B

Wanted, Post as Chief Draughts- MAN or WORKS MANAGER of small Engineering Works. Marine, electrical, and general engineering experience.—Address, 414, "The Engineer" Office. 414 B

To Aeroplane and Munitions Manufacturers.—DRAUGHTSMAN offers his SERVICES on completion of erection of large national factory. Well versed in planning and building requirements for aero and munitions plant. Quantities, handling of men, speedy erection, supervision and accounts.—Address, 2.5, "The Engineer" Office. 275 B

Practical Engineer Desires Re- ENGAGEMENT as FOREMAN. Good all-round man; accustomed to general engineering and repetition work, fine limits, jig, tool and gauge making, capstans and turrets; good organiser.—Address, P892, "The Engineer" Office. P892 B

A Large Firm of Engineers in the Midlands HAVE an OPENING for a YOUTH of Good Education as PREMIUM PUPIL, the course to include both Works and Drawing-office. Address, 2002, "The Engineer" Office 2002 B

Inst. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. F. KNOWLES, B.Sc., A.M.Inst.C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Hundreds of successes during the past twelve years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. 236 B

Penningtons, Engineering Tutors Postal Courses in Mechanical Engineering, also A.M.I. C.E., and A.M.I.M.E. Introductory Course in Engineering Mathematics and Mechanics.—254, Oxford-road, Manchester. 2018 I

A London Company of Sound financial standing having large warehouse and a first-class connection, amongst merchants (home and export), DESIRE to HEAR from MAKERS of SPECIALITIES usually bought by Tool Factors, Mill Furnishers, and Wholesale Ironmongers, with a view to act in the after-war period as Representatives, or would contract for the whole output, acting as Wholesale Distributing Agents. Advertisers have in formation a branch in allied European countries, so as to be prepared for the after-war trade. Agency for any country also entertained. All negotiations to be mutually confidential.
Address, 6, "The Engineer" Office. 6 B

United States.—City Merchant leaving shortly for New York is OPEN for BUYING COMMISSIONS in the Allied Steel Trades, Motor Cars, and Accessories, &c. Can finance all shipments.—Address, 413, "The Engineer" Office. 413 B

Directorship Required by an Experienced Civil Engineer having capital and extensive commercial connections. Give full particulars, stating capital required for investment, and amount of fees per annum.—Address, 297, "The Engineer" Office. 297 C

Engineer with £10,000, Experi- ENCED and responsible, DESIRES MANAGING DIRECTORSHIP in or near London, in a large Engineering or Manufacturing Company.—Write, WHEATLEY KIRK, PRICE and CO., 45, Watling-street, London, E.C. 398 C

Managing Partner Wanted, in place of Partner wishing to take less active part, in Engineering and Ironfounding Business in West Riding Town.—Address, for particulars, 420, "The Engineer" Office. 420 C

Wanted, Air Compressor, Verti- CAL, Motor-driven type; 100 250 cubic feet of air per minute; pressure 50-100 lb. per sq. in. Send price and full particulars.—Address, 421, "The Engineer" Office. 421 F

Wanted at Once, a "Cochran" BOILER, about 12ft. 6in. × 6ft., and, say, 45 H.P. Must have a working pressure of not less than 160 lb., and be in good condition. Must have immediate delivery.—Apply, MAGNA CIDER CO., Marston Magna, Somerset (via Bath). P889 F

Wanted, Good High-speed Ver- TICAL GENERATING SET preferably by Bellis and Morcom; compound wound generator, 120/150 kilowatts, 230 volts, suitable for steam pressure of 100 lb. per sq. in.—Address, 395, "The Engineer" Office. 396 F

Wanted, Good Modern Hori- ZONTAL SAW.—Full particulars and lowest cash price to JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence Hill, Bristol. 387 F

Wanted, Immediately, 500-600 K.W., D.C., 220 volts GENERATING SET; Diesel Engine preferred; either direct-coupled or rope-driven.—Full particulars and price to MARSHALL, SONS, and COMPANY, Ltd., Gainsborough. 313 F

Wanted, Producer Gas Plant, consisting of 2 1000 H.P. Producers, Mechanical Gas Coolers, Rotary Tar Extractors, Gas Washing Towers, Sawdust Scrubbers, &c. Good second-hand plant complete, or any of the accessories separately, would be considered. Give full particulars, prices, &c.—Address, 395, "The Engineer" Office. 395 F

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.R., Smith's Agency, Ltd., 100, Fleet-street, E.C. 1 F

Required 5-Cwt. Steam HAMMER, in first class condition.—Full particulars, and illustration if possible, to 310, "The Engineer" Office. 310 F

Vertical Gas Engine, for Town Gas, WANTED IMMEDIATELY, 75 to 250 H.P. Must be in excellent condition. Direct coupled to generator preferred.—JARDINE, Nottingham. 389 F

American Cup Grease.—100 Barrels for Sale, ex wharf, London. Test by Redwood:

	Per cent.
Unsaponifiable Oil (Petroleum Lubricating Oil)	76.0
Dry Lime Soap	21.3
Water	2.7
	100

Please send offers to Box 291, Messrs. T. B. Browne's Advertising Offices, 163, Queen Victoria-street, London, E.C. 4. 385 G

American Superheated Steam CYLINDER OIL.—About 80 Barrels 630 Flash Dark Cylinder Oil for Sale. Test by Redwood:—

Sp. Gr. at 60 deg. Fah.	910 deg.
Flash Point—Open	614 "
" " Closed	568 "
Fire Test	682 "
Viscosity	200/250 deg.

Please send offers to Box 294, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, London, E.C. 4. 386 G

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c. 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London S.E. Telephone No. 978 Hop. 822 G

For Sale:—

One 600 K.W. GENERATING SET, Engines by Bellis and Morcom, Ltd.; cyls. 16½ and 25in. × 42in. stroke "Parker" Generator, 500 volts D.C. Complete with surface condenser, motor-driven Pumps, &c.

One 125 K.W. Ditto ALTERNATOR by Ferranti, Ltd., 2000 volts, 50 periods. Vertical Cross Compound Engine, 250 H.P., by J. and H. McLaren.

250 H.P. VERTICAL CROSS COMPOUND CONDENSING ENGINE, by J. and H. McLaren, Surface Condenser, Pumps, &c.

MIRRLEES-WATSON CONDENSER, with separator, but without pumps, 30,000 steam per hour, 3000 sq. ft. cooling surface.

PAIR CROSS COMPOUND ENGINES, 600 H.P., 26in. h.p. cyl., 40in. l.p. cyl., 4ft. stroke, Corliss valves to h.p. cyl., slide valve to l.p. cyl., fly-wheel 30ft. dia., by Barclay, Sons and Co., Ltd.

CROSS COMPOUND HORIZONTAL ENGINE, 14in. h.p. cyl., 22½in. l.p. cyl., 33in. stroke, 12ft. dia. fly-wheel, by Davy, Paxman and Co.

WORM-GEARED CAPSTAN, 5½in. dia. cyls. by 8in. stroke, link-reversing motion, worm geared 90 to 1, drum 2ft. by 1ft. 6in. wide.

MORTAR MILL, under driven, 6ft. dia. pan, engine 7in. × 12in.

R. H. LONGBOTHAM & CO., Ltd., WAKEFIELD,
& AT MILBURN HOUSE, NEWCASTLE-ON-TYNE.
Tel.: 44 Wakefield; 867 Newcastle.
Tel. Add.: "Engineer, Wakefield." 2017 G

For Sale:—
Quantity good SECOND-HAND 18in. gauge
PORTABLE RAILWAY
complete with Two TURNTABLES and Three Sets POINTS and CROSSINGS to suit. 15 Set 24in. Gauge Points and Crossings, new C.I. Turntables, 24in. gauge. Sleepers, Crossing Timbers, and Pit Timber.
B. M. RENTON and CO.,
Market-place-buildings, High-street, Sheffield. Spl 3006

FOR SALE,
Large Quantity YORKSHIRE
and other GAS COKE.
THOS. DUXBURY and CO.,
N123 Grosvenor Chambers, Manchester.

For Sale:—

Two LANCASHIRE BOILERS, each 28ft. × 7ft. for 180 lb. working pressure, complete with Hopkinson stokers. Quick delivery.

A 100/110 K.W. steam-driven ELECTRIC GENERATING SET; engine by Willans; dynamo by Electric Construction Company; 400-430 volts, or would sell engine without dynamo.

Three power-driven BOLT SCREWING MACHINES, up to 2in.

Several LATHES, 8in. to 16in., requiring slight repairs.

Horizontal BORING MACHINE, with rising table 6ft. × 2ft.

Two Sets of 4-Ton LIFTING TACKLE for running on joists; all motions by hand.

One Set of 5-Ton ditto.

One Set of 7-Ton ditto.

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600, Commercial-road,
London, E. 14. 2012 G

For Sale, Blower, 5in., with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1703 G

For Sale, Economic Type Boiler, 13ft. by 8ft. 6in., passed for 160 lb. pressure.
Ditto, 12ft. by 8ft., passed for 150 lb. pressure.
30ft. by 8ft. 6in. LANCASHIRE BOILER, 100 lb. pressure.
SHAW and GASKELL, Hull. 416 G

For Sale, Just Off 6in. Shell Con- TRACT, 8 LATHES, 1 Asquith PILLAR DRILL, 1 Holroyd SCREW MILLER, 1 Hydraulic COPPER BANDING PRESS.—Full particulars, apply S. RICHARDS and CO., Limited, Engineers, Lowestoft. 419 G

For Sale, Metal Pipes; About 70 ton C.I. Spigot and Socket Pipes, 8in. by 9ft. by 9·16in.—Apply, JAMES WATERSON, 49, Waring-street, Belfast. 400 G

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For Sale, One 140 B.H.P. Horizontal Hornsby-Stockport GAS ENGINE, with magneto ignition, heavy fly-wheel, complete with Suction Plant of two Generators and cleaning apparatus. Immediate delivery. In first-class condition.—Address, 356, "The Engineer" Office. 356 G

For Sale or Hire, Electric MOTORS, from 6 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-Street, London, E.C. Tel.: City 3938. 2025 G

For Sale, Second-hand Pumps:—
Vertical 3-throw, 7½in. gun-metal plunger; engine driven; 10,000 gallons; by Hayward-Tyler.
Horizontal Compound Duplex, cyls. 10in. and 16in. dia.; 8in. G.M. plungers; 200 lb. pressure.
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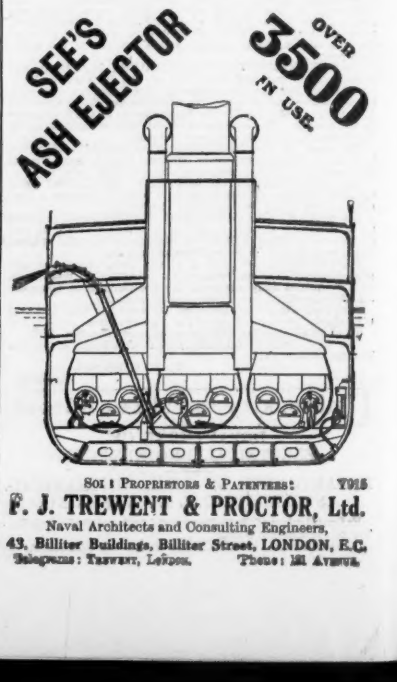

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THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. I.

The excellent work done by the "Tanks" on various fronts has caused a good deal of attention to be directed towards what is popularly termed the "caterpillar" form of tractor. It will perhaps be of interest, therefore, if we trace the evolution of the chain-track tractor, of which this machine is one of the forms. In doing this we shall have occasion to refer to a very large number of proposals, many of which were for designs quite unlike the present day developments, and which might, therefore, appear to have no immediate bearing on the subject under consideration. But they all had more or less the same object, and all, therefore, may be considered as forming links in the history of the chain-track tractor of to-day.

The idea of distributing the weight of a vehicle over a greater area than that provided by its own wheels is by no means new. Quite early in the last century—and, indeed, before then—inventors were busy in endeavouring to solve the problem, and some of them achieved a transitory measure of success, since they produced arrangements by which vehicles could traverse ground that otherwise would have been impossible for them. It is quite evident, however, that no one succeeded in evolving an entirely satisfactory solution, since in only a single case—that of Boydell—did any one of the very numerous suggestions have a long lease of life, and the invention of Boydell, which we shall refer to later, though it was certainly employed for some time, was eventually discarded. Nevertheless, it contained the germs of success. What actually happened was that the wheels of traction engines and other vehicles intended to propel themselves on ordinary roads were made wider and were provided with the familiar diagonal slats. The combined effect of these two was that for all ordinary purposes sufficient bearing surface and grip on the roadway was obtained.

Inventors, however, were not content to let the matter rest there. In his book entitled "The Economy of Steam Power on Common Roads," which was published in 1860, Mr. C. F. T. Young gave a list of patents taken out during the ninety years prior to that date, all of which had reference to this question. From that book we quote the following instances. The first patent mentioned is that of Richard Lovell Edgeworth, which was taken out in 1770. It was for a portable railway, or artificial road, to move along with any carriage to which it was applied. According to Mr. Young, "it consisted in making portable railways to wheel carriages, so that several pieces of wood are connected to the carriage, which it moves in regular succession in such a manner that a sufficient length of railing is constantly at rest for the wheels to roll upon, and that when the wheels have nearly approached the extremity of this part of the railway, their motion shall lay down a fresh length of rail in front, the weight of which in its descent shall assist in raising such part of the rail as the wheels have already passed over, and thus the pieces of wood which are taken up in the rear are in succession laid in the front, so as to furnish constantly a railway for the wheels to roll on." It appears probable from this description, as Mr. Young remarks, that the pieces of wood alluded to were connected together in such a manner as to form an endless chain or series.

Thirty years and more, apparently, went by without any patent dealing with the subject being obtained. Then in 1801 Thomas German patented a means for facilitating the transit of carriages on common roads by substituting endless chains, or series of rollers, for the ordinary wheels. Seven years later a somewhat curious patent was taken out by a Mr. John Dumbell, part of the object of which was to substitute "Gothic or other kind of arches, globes, semi-globes, or segments" for the ordinary wheels of carriages, in order to "prevent sinking on inferior roads or bad ground." In 1812 William Palmer patented the use of a connected series of endless chain of rollers as substitutes for the wheels of carriages. There were, according to Mr. Young, two applications of this invention—one as revolving rollers, and the other revolving roller wheels.

In 1821, a Londoner, John Richard Barry, patented a machine which was designed to "enable a carriage to pass over the most rugged ground without receiving any obstruction from large stones or other abrupt impediments lying in its path." The contrivance consisted of two endless pitched chains, stretched out by and passing round two chain wheels, at each end of the carriage, one on each side, the axes of which revolved in bearings in the side frames of the carriage which formed the rails or bearing surfaces of the carriage.

In 1822 another peculiar invention was patented, this time by David Gordon, who designed and constructed several road locomotives. This particular invention was for "improvements in carriages to be drawn by elemental power." The carriage consisted of a large rolling drum 9ft. in diameter and 5ft. wide from end to end. In the inside was "an iron rack extending like two hoops at equal distances apart round the interior of the drum." On this rack inside the drum a four-wheel locomotive engine "on the plan invented by Trevithick," having wheels fitted with teeth working into those of the rack, was placed. When the engine was started it climbed up the drum like a squirrel in a cage, and the drum moved forward! Steering was effected by a carriage in front which was connected by two side frames to the engine.

A somewhat similar proposal to that of Mr. Barry, but differently applied, was patented by Sir George Cayley, of Brompton, in Yorkshire, in 1825. In the proposal of James Neville, which was patented in 1827, a series of flat spring plates was fastened round the tires of the wheels. Each plate formed a tangent to the circumference, so that as the wheels moved forward each plate was bent against the tire and recovered its tangential position as it left the ground in its revolution.

A practically identical invention was (*a*) patented in 1825 by G. Hunter, of Edinburgh, (*b*) communicated by an American to Mr. Gillet, of Birmingham, in 1830, and (*c*) subsequently re-patented by other persons, including Sir James Caleb Anderson and Henry William Ford, both in the year 1857. It was designated a "perpetual railway," and was, according to Mr. Young, when referring particularly to the American's idea, "formed by a circular rib or rail placed round the interior or felloe of a broad driving wheel, on which rail a small wheel with a grooved periphery is intended to run, and which wheel carries the whole weight of the carriage, and by running on a smooth even surface it was presumed it would greatly facilitate the progress of the carriage when the larger wheels were passing over uneven ground."

Another application of endless chains was patented by John Ashdowne in 1836. It was intended for "facilitating the draught of carts, wagons, or other carriages on turnpike or common roads." The chain was composed of short iron bars connected together by pin joints, and it was made to pass round the wheel and over a lever guide suspended in front of the wheel. Henry Pinkus patented the use of a metal rim—say 12in. wide—bolted on the periphery of each wheel, and the employment of "an endless apron of coarse mesh wire gauze . . . stretched round the fore and hind wheels on each side of the engine. . . ." The apron moved round with the wheels which ran upon it. This was in 1839.

A kind of movable or portable railway, or road, which was laid down, travelled over, taken up and carried by the machine itself, was patented in 1840, by John Leo Nicolas for use especially in marshy and boggy country. In 1846 Edmund Leahy patented an "adaptation of a series of short rails to the wheels of carriages, which rails were linked together in a manner somewhat resembling an endless chain." Each wheel was always to bear on at least one of the rails or links of the chain.

This year—1846—was somewhat prolific in patents dealing with the same subject. There was first of all that of Mr. James Boydell, which can be described in his own words: It was a "mode of applying moveable detached parts of a railway to the wheels of carriages, whereby each part is successively placed by its wheel on the road or land over which the carriage is to pass; each piece of the railway, when down, allowing its wheel to roll over it; and the wheel lifts the pieces of the railway successively, and holds each piece in such position as to deposit it correctly when that part of the wheel which carries a part of the railway again comes near the earth; by which means a railway will continuously be formed and broken up as the carriage is drawn along a road or over land, by which the power required to draw a given load will be reduced." Mr. Boydell improved upon this device and obtained a further patent in 1854. In this the parts of the rails on which the wheels of the carriage ran were each fixed to a plate, made by preference of wood strengthened with iron, so that the surface bearing of the plate was considerable as compared with the width of the tire of the wheel. The plate extended considerably on both sides of the rail on which the wheels ran. The ends of the bearing plates were made so as to match into each other, and in each case to extend beyond the end of the portion of rail which a bearing plate carried, so that when a carriage wheel came to the end of one portion of rail, it did not come to the end of the bearing plate on which that part of the rail was fixed, but was received on to and supported by the next portion of rail before the wheel had passed beyond the end of the previous bearing plate.

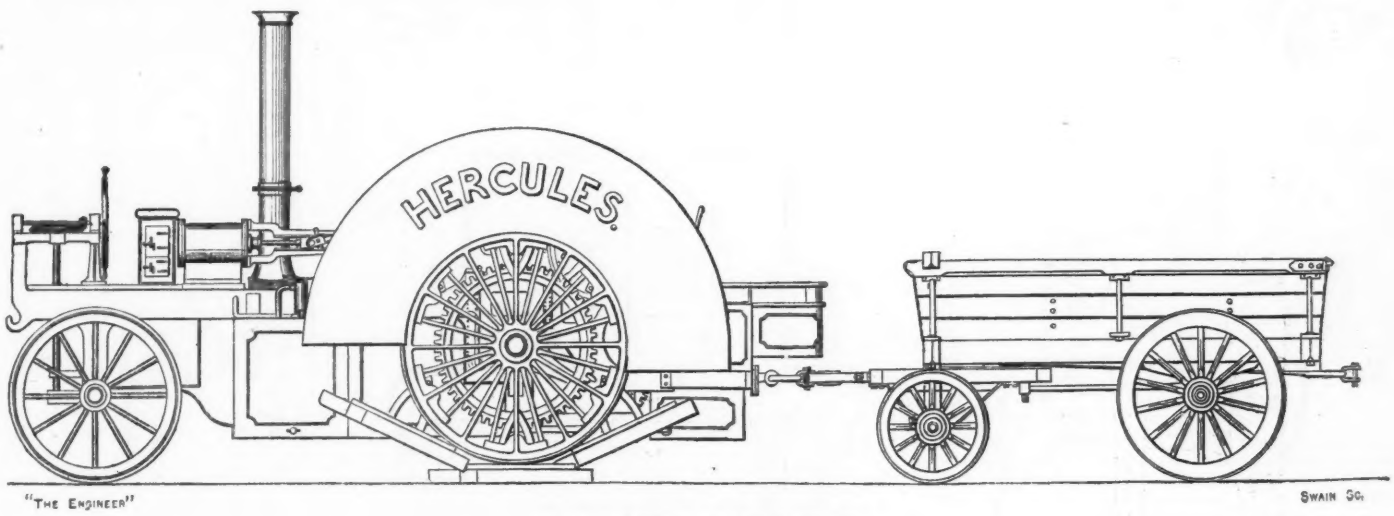


Fig. 1—A BOYDELL TRACTION ENGINE

A drawing of a traction engine constructed on the Boydell system is reproduced in Fig. 1 from a woodcut given in Mr. Young's book. According to that authority it was the only arrangement of the many patented which "up to the present time"—1860—"... can be regularly and profitably worked over the same ground without injuring it, and ... the only engine on this principle which has ever been regularly worked. ..." It is worth while to quote from a report made to the Government by Mr. F. C. Danvers, an engineer from East India House, on the working of a Boydell engine. He says: "It is a pretty sight to watch the action of these shoes, the way in which the wheel deposits them on the ground, and again lifts them up, after having passed over, not being a heel-and-toe action, but sudden and flat, the whole surface of the shoe reaching the ground, and again leaving it simultaneously; they run entirely free and independent of each other, and no obstacle on the road could seriously interfere with their working."

There was in 1846 also the invention of Henry Wrigg, which was "for constructing every description of carriage, so that its weight shall always be borne by rails attached to the carriage, and resting or moving on one or more of an endless chain of friction wheels caused to revolve by the traction or propulsion of the carriage in a longitudinal direction, and this, whether such carriage move on prepared or unprepared ground, and whether it is propelled by animal, steam, or any other power." In the same year William Pidding patented a means of applying a portable railway to ordinary road carriages, which consisted of a series of rollers with their axes connected by links so as to form an endless chain which encircled the frame. Each link carried a small wheel which stood at right angles to it. The wheels kept the rollers at some distance from the ground, and the rollers served to support the carriage. The same inventor

proposed to employ endless bands of plates, which passed under the wheels and served as a roadway. The bands were kept in motion by the rotation of drums or rollers driven by the wheels of the carriage. This invention was improved upon in 1852, and a further patent taken out.

Two patents were taken out in 1847. One was by James Morrison for a carriage wheel "carrying a series of rails on which it travels," and the other by Sir John Scott Lillie for "an endless railway formed of wooden planks, or wrought iron plates hinged together, so as to turn freely over the drums, and circulate around the bearing wheels of the carriage which travels thereon." A Mr. James Nicholls Marshall describes an invention which he patented in 1852 as being for "an improved wheel for carriages and other vehicles." In this two cog-wheels were made fast, one on each side the tire of a wheel. There were fourteen revolving cog rails and fourteen revolvers for the cog rails to work and turn on a pivot that ran through the revolver, and through the rails, and was made fast to the tire of the wheel with a joint that allowed the revolver and the rails to lie flat on the ground while the cog-wheel passed over them.

Another "endless railway" was patented by William C. Cambridge in 1856. It was for "facilitating the movement of engines, carriages, &c., over loose ground and irregular surfaces." To each wheel was adapted a set of plates or sustaining pieces made flat on their underfaces, which "severally receive in turn the pressure of the wheel as it revolves." The railway was not fastened to the wheels, but merely formed a kind of endless chain around the periphery from which it might be removed by "withdrawing a junction pin or bolt from one of the pairs of levers or links so as to break the continuity of the endless chain."

The year 1857 was again prolific as far as the numbers of patents dealing with this subject were concerned, but apparently most of these patents were either for revivals of ideas which had been previously patented or were not of any particular value. We may, however, record the names of the patentees. They were: Isaac and Robert Blackburn, Sir James Caleb Anderson, Henry William Ford, John Fowler, jun., Robert Burton and Thomas Clarke, Hamilton Henry Fulton and Thomas B. Etty; Dumarchey, Levy and Mayer; William Clark, and James Welsh. Quite a number of patents was also taken out in 1858. There was that of Andrew Whytock, which was for "improvements in apparatus to be applied to wheels to facilitate them in travelling on common roads and other surfaces." Then there was the patent of Edmund Scotson and Henry Charnley, which was for improvements in traction engines, and in "Endless Railways." It consisted of a chain provided with as many studs and lozenge-shaped pieces as would reach entirely round the wheel. The sections were so arranged that, as the revolution of the wheel carried them round, they were successively laid down in front of the wheel. The patent granted to Thomas Rikett was for a contrivance which was very similar to the endless band or web proposed by Pinkus in 1839. The patent of John Fowler, jun., and Robert Burton, which was taken out in August, 1858, warrants a little fuller reference. It was to be applied to locomotive and other carriages and was "to facilitate their movements on common roads and other surfaces." In it the axle—or it might be the axles—of the carriage was supported at its ends by frames, which were in turn supported on wheels which ran upon rails laid by the carriage in its progress. The wheels had flanges on both sides of the tire, and an endless chain of short sleepers or bearers, each having a length of rail bolted longitudinally to it, passed round each pair of wheels.

In the same year patents were taken out by Charles Henry Thurnham; James Braby sen., and James Braby, jun., and Charles Burrell, of Thetford. The last named was for a modification of the means for attaching the shoes of Boydell's endless railway to the wheels of engines and carriages.

It will be seen from the foregoing how many brains had been at work on this subject, and the wonder is that more lasting success was not achieved. The fact appears to be, however, that with the exceptions of the invention of Boydell, not one of those we have mentioned, was, as far as we are aware, ever employed commercially.

In the House of Commons recently, the First Commissioner of Works was asked whether, as a result of research and experimental work which had been carried on by glass manufacturers, a glass had now been produced of as good quality as Jena glass; and, if so, whether he would give an undertaking that no more orders would be given by the Government to a firm of German origin? The reply was that a special fire-resisting glass could now be made in this country, but as the firms which had facilities for its manufacture were engaged on more important work for War Departments, it was not practicable to place orders with them for that glass in chimney form. In the circumstances effect could not be given to the suggestion in the last part of the question without harm to the public service.

SOME BULB EXPERIMENTS ON HOT BULB ENGINES.

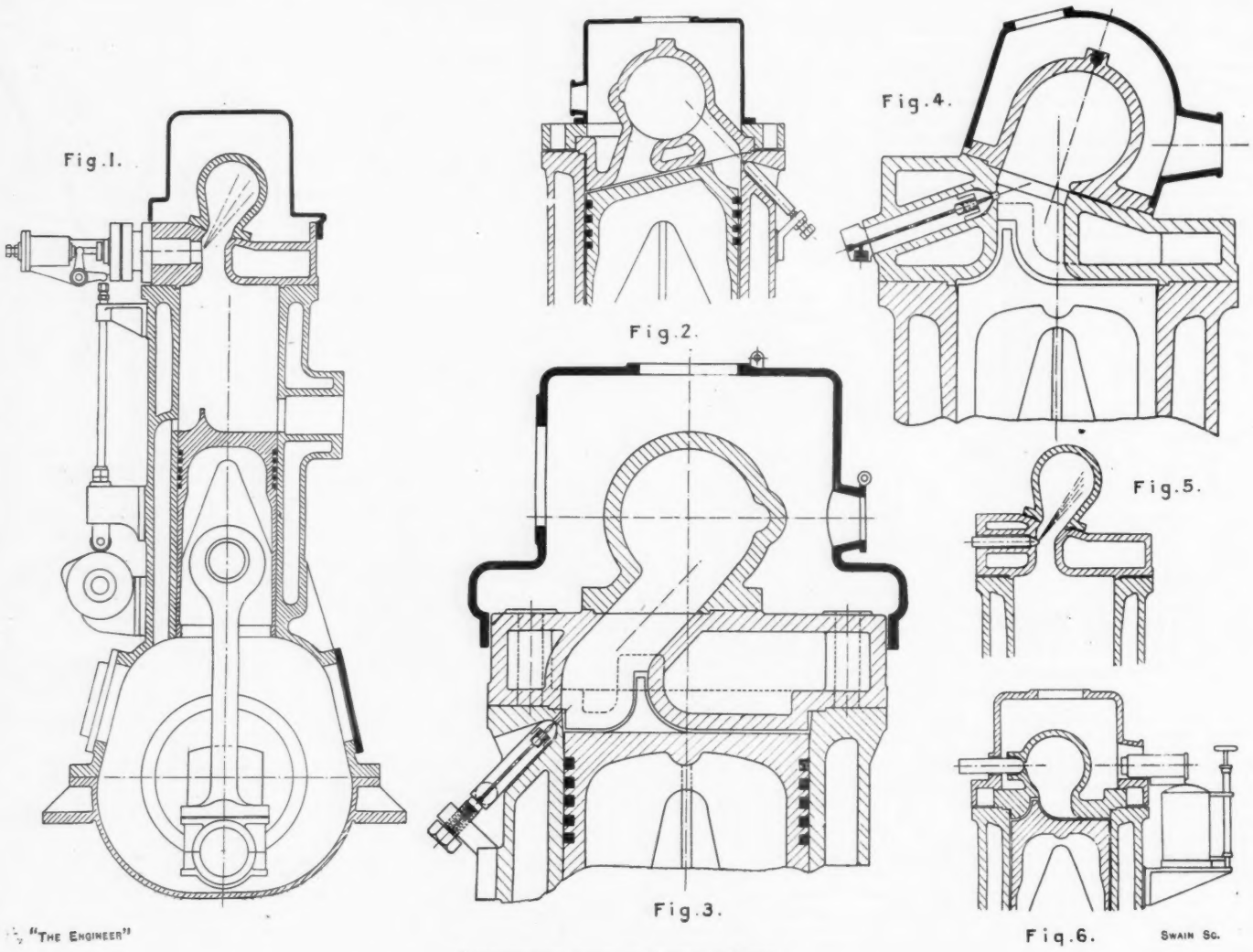
(By a Correspondent.)

With the hot bulb engine it is always a matter of considerable difficulty to get absolutely complete combustion of the fuel oil. In many instances the writer has been able to get engines the exhausts of which were as nearly perfect as any hot bulb engine can ever hope to be, but after a few weeks running a dirty exhaust developed, which was due mainly to the unskilled and cheap labour available for attending to the engines. In a pure Diesel engine, where highly compressed air is used to pulverise the oil, the problem is rather simpler, and perfectly smokeless combustion, even with the heaviest class of fuels, can be got, and consequently a low fuel consumption registered, despite the fact that 8 or 10 per cent. of the engine power is used to drive the injection air compressors.

In all engines that inject the oil direct into the cylinder with a pump, the oil enters as a jet, and as it is in a more or less solid form, it is extremely difficult to obtain smokeless combustion, owing principally to imperfect pulverisation, causing the particles of oil to be too large to burn completely during the short period the oil is in the cylinder. This system is called the solid injection system, and may be applied to pure Diesel engines as well as to hot bulb motors, highly compressed, and therefore highly heated, air being used for ignition instead of the hot bulb.

The effectiveness of the air injection system as compared with the solid injection system for obtaining a smokeless exhaust can be easily understood. With the solid injection system, even under very high pressures, the fuel moves at a comparatively slow speed when emerging from the jet, and thorough mixing with the air in the cylinder cannot be obtained. If the nozzle is of an imperfect form, there is also a danger of the oil carrying over too far and depositing on the sides of the combustion chamber.

It is also easy to see that there must be a certain amount of dribbling at the jet during the time the oil column is accelerating to get up sufficient speed to carry it into the combustion chamber, and also when it is decelerating or finishing. These drops fall on the piston and water-cooled parts of the engine, where they cannot be properly vaporised or burned, so that a smoky exhaust results and the piston rings and combustion spaces get clogged up with unburnt carbon.



EXPERIMENTS WITH HOT-BULB ENGINES

With air injection the speed of the oil is easily five to ten times greater than with solid injection, and the oil is broken up into very much finer particles. It is, therefore, possible to get great turbulence and mixing in the combustion spaces, giving high mean pressures and clean combustion.

A rather complete series of experiments was carried out by the author on a large hot bulb engine to determine the best form of bulb, and, if possible, evolve a type that would not require the water drip to keep the bulb at the proper temperature. Both air and solid injection systems were tried, and whilst no absolutely uniform conclusions can be drawn from the experiments, they determined forms that could safely be claimed as smokeless, with certain classes of heavy oils. It was also found that when new sizes of engines were built embodying the best results, some of them did not come up to expectations, whilst others exceeded the best that had been obtained, thus illustrating the often repeated statement that each size of each type of oil engine is a law unto itself. Some peculiarities were also discovered that should be of great assistance to any designers in this class of work, and should prevent an unnecessary repetition of the same experiments.

Fig. 1 shows a section of an ordinary crank case compression two-cycle hot bulb motor. This particular engine was fitted with a two-stage air compressor having inter and after-coolers, the injection air being compressed to 500 lb. per square inch, this pressure being sufficient to overcome the maximum explosion pressure of 350 lb. per square inch occurring in the cylinder. The cylinder cover was water-cooled, and the injection valve was placed horizontally in it, so that it was necessary to deflect the jet up into the bulb by drilling the nozzle hole at an angle.

In all the designs of hot bulb motors with water-cooled cylinder covers, the bulbs are very small as compared to those—see Fig. 2—in which the bulb and cover are made as one uncooled casting. The bulbs are therefore very cheap to replace, and as the air in the cylinder is kept cooler by the cover it is denser, and consequently a higher mean pressure can be supported and a more powerful engine offered. This was clearly proved from the experiments, and the practice is now being followed by many manufacturers.

For the air injection type, the form of bulb shown in Fig. 1 was found to be the best and most durable, and practically all classes of fuel could be smokelessly consumed. In addition, it was possible when the correct compression was found—about 140 lb. to 150 lb. per square inch—to run at full speed without the aid of a water drip to regulate the temperature of the bulb. It did not show any signs of overheating or wear, and, if necessary, could take a considerable quantity of water, sufficient to give an increase of 20 per cent. in the power, without in any way causing the engine to missfire by cooling the bulb too much.

The water-cooled cylinder cover possesses an advantage not given by any other type, which is very convenient should the supply of water give out. It will be noticed that the air is compressed into the bulb through a water-cooled throat. By regulating the temperature of the water round the throat, the temperature of the bulb can be kept within all practical limits. When it is required to do this, a water pipe with a valve in it should be taken direct from the cooling pump to the cover, so that the coldest water is available. The usual practice is to take the water from the cylinder jacket into the cover, but this water is too warm when it is desired to use this system of bulb temperature regulation.

Nothing in the nature of dribbling at the jet occurs, as the air blows all the oil in and leaves the end of the nozzle clean, and the valve seat free for the valve to seat sharply. Certainly, the air compressor adds a complication to the engine and makes it more expensive to manufacture. On the other hand, it gives a more powerful engine and a clean exhaust, and no serious clogging of the piston or bulb occurs, so that overhauls are rendered less frequent.

As a rule, it is safe to estimate an increase of 15 per cent. in the power over solid injection engines, and the price can, accordingly, be advanced by that amount, which more than pays for the complications added by the compressor. On the other hand, it requires a more intelligent driver to operate the engine, and this type should only be installed where good attention can be given. It is also better adapted for the larger sizes of engines, and it is the writer's opinion that it should not be fitted to engines giving less than 40 to 50 brake horse-power per cylinder.

Practically speaking, any form of bulb—Figs. 1 to 6—can be used for air injection, and in every case smokeless combustion can be obtained without any great deal of experimenting. It was found that the testing expenses and time required for tuning up was less for a new size of engine of this type than for a new size of the solid injection type.

For the solid injection experiments the form of bulb shown by Fig. 2 was tried. Although this form is used with great success on a famous engine, it was found in the present experiments to be by no means the best. It was rather smoky, and for reasons already given, the power also was not high. The fact that a certain proportion of the air in the passage leading into the bulb furthest away from the jet cannot be directly attacked by the oil jet, would, no doubt, tend to keep down the mean pressure. This type proved to be rather costly to make and to renew when any cracks developed.

The type shown by Fig. 3 easily gave the best results, despite what might be thought to be some serious drawbacks. For instance, the jet is situated in the cylinder jacket, and the oil has to travel through the long water-cooled hole in the cylinder cover before reaching the hot bulb. It would be natural to expect some dripping of the oil column on to the piston and cover, and, consequently, incomplete combustion and a smoky exhaust. On the contrary, with paraffin, shale oil, and gas oil, the exhaust was perfectly clean, full power was obtained without the assistance of the water drip, and no overheating of the bulb took place. With the water drip, an increase of 25 per cent. in the power was easily maintained for long periods, and without the expenditure of any additional fuel oil.

The reason why this type of bulb keeps cool without the water drip is to be found in the fact that the whole of the flange of the bulb is in contact with the water-cooled cover. Should the bulb tend to keep cool its temperature can be nicely adjusted by relieving some of the flange, so as to reduce the surface in contact with the water cooling of the cover.

The power obtained from this type was only excelled very little by the air injection engine, and the bulbs proved to be very durable. The good results obtained from this bulb led the designers to think that better could be got by greatly reducing the distance the oil had to travel before reaching the bulb, and the form shown by Fig. 4 was tried, in which the nozzle is placed in the cylinder cover and much nearer to the bulb than it was in Fig. 3.

It would be as well to point out that the object aimed at in the bulbs shown by Figs. 3 and 4 was to inject the oil at a tangent to the inner surface of the bulb, and get a concentric swirling action to assist the mixing and combustion of the charge.

For reasons which could not be fathomed or even partially explained, this one—Fig. 4—was a comparative failure, and gave nothing like the results of the one shown by Fig. 3, notwithstanding the fact that everything had been done to keep the compression and all else the same, in order to make the experiment a success.

The variation shown by Fig. 5 was next tried, but again failure was registered, and no satisfactory explanation could be offered. Repeatedly the writer has been faced with this inability to offer a suitable explanation for a failure in oil engine work—especially with the solid injection system—when everything pointed to success. It only goes to show that the margin between success and failure is very little, and at all times elusive.

The idea was carried a bit further and the nozzle put directly in the bulb, as shown by Fig. 6, but with no better success. During the design of this type various faults were obvious, but it was very much desired to try the experiment, and if it had succeeded some of these faults could easily have been eliminated. For instance, it was seen that the force required to press the nozzle against the bulb to make a joint would be great enough to distort the bulb when it was at a dull red heat. This actually happened, and in time the bulb gave way at the neck. This, of course, could have been obviated by pulling the jet against the bulb by means of studs screwed into the bulb instead of into the adjacent cast iron cover. Then, again, the heat of the bulb kept the nozzle very hot, and the oil gasified before issuing to the cylinder, with the result that the hole was not big enough to pass the required amount of oil, and after the engine had been working a short time the power fell away.

This could have been overcome by putting a water-cooled cage into the bulb to carry the nozzle, but complicating the bulb in this manner would render it liable to crack and become distorted when it got hot.

The poor results obtained from the initial experiment did not justify any more money being spent in this direction, and the idea of putting the nozzle direct in the bulb was abandoned. From the all-round results of the solid injection experiments, the form shown by Fig. 3 proved to be easily the best, and was therefore adopted as a standard.

THE CAREER OFFERED BY THE ENGINEER'S DEPARTMENT OF A BRITISH RAILWAY.

(By a Correspondent.)

Many a boy wishes to become an engineer without having very definite ideas as to which branch of engineering he means to enter. Some day the English-speaking races will define more exactly what is meant by the term "engineer," and by the various qualifying adjectives usually applied to the word. One is often reminded by such expressions as the following:—"The engineers on the North-East Coast are out on strike," "the engineer was oiling his locomotive," "John Smith, sanitary and hot water engineer," that the word has an extremely wide application. "The Chief Engineer" of a railway means the chief civil engineer, and the other technical officers are named "Chief Mechanical Engineer," "Chief Electrical Engineer," "Chief Engineer for Docks," &c., the latter being, of course, in charge of a branch of the civil engineer's department, and not always holding a separate appointment.

Whether a scheme of nationalisation of railways in these islands will be brought forward after the war, or whether the present system of Government control will be continued in some modified form, or whether the pre-war state of affairs will be resumed, are questions which have a great interest for the railway staff, but are not easy to answer at present. The effect of nationalisation on the prospects of the staff is a matter of opinion, dependent on the point of view of the individual. In any event, our railways will continue to attract our young men and to provide them with a career.

It is most important that in order to secure the best and brainiest of the youth of this country, they should offer careers equal to those in the great Government departments or in private professions. The position of an engineer on a railway is different from that of men in non-technical departments, since it is usual and necessary for the chief positions to be filled by qualified engineers, who, having had a proper training, have become members of the engineers' profession, and may be described as "Engineers," as distinct from draughtsmen, surveyors, and the like. It is not reasonable to suppose that the best type of fully trained men will be attracted to a railway career, unless his qualifications are recognised as giving him a higher claim to promotion than is conceded to the untrained or partially qualified assistant.

A few points concerning the position and training of railway engineers present themselves, some of them being equally applicable to other departments of the railway. It may be well to consider whether a more thorough system of organised training might not be introduced into the engineer's department, with the object of improving the prospects of the junior assistants, and at the same time assisting the head of the department in making appointments to vacancies as they occur. The examination system has been largely adopted in the traffic departments of most of our railways, and candidates for promotion must qualify themselves by passing certain tests of knowledge. It has not been applied on the same scale in the engineer's department, since the conditions there are different. In the operating and commercial department every youth who enters the service may rise to the higher posts, provided he is equipped with the necessary brains, energy, and perseverance. In the engineer's department the engineering and clerical staffs are entirely distinct, since only qualified engineers can hold the higher posts, and even the junior supervising appointments in the drawing-offices are open only to technical men. Although the technical engineering staff may be placed in two categories, viz., fully qualified engineers and surveyors, or draughtsmen, the latter may, of course, by special study and experience succeed in qualifying themselves as engineers; but unless they do so they cannot rise out of the drawing-offices.

What then is the position, and what are the prospects of an engineering student who enters the office of a railway engineer at the outset of his career? Further, what organisation can be devised to ensure a succession of trained engineers for vacancies in the higher ranks? These two questions are intimately connected, because the opportunities of advancement which will present themselves to the young engineer depend largely on the organisation of the department and on the existence or non-existence of a clearly visible avenue of promotion. One is sometimes told that railway construction in this country is at an end, and that the only career for a railway engineer, as distinct from an operating or commercial railwayman, is to be found in the Colonies or India. This is not wholly true, as there is a great deal in railway engineering besides the construction of new lines. The maintenance of existing railways requires a very large staff of highly expert men, and, as a matter of fact, construction is by no means at an end, every year seeing projects for new lines deposited in Parliament.

The training of a railway engineer is a long process, and the experience gained during three or four years of pupilage is rudimentary, being mainly concerned with "engineering" as distinct from "railway working."

It is impossible to lay too much stress on the fact that a railway engineer must not only be an "engineer," but he must also be a "railway man." He must be well grounded in the principles of engineering, and will need and use them all his life; but he must also acquire a knowledge of railway working, and must cultivate an aptitude for managing a large and important department in a business-like way. He must be an engineer, a business man, and a railway expert, all in one. His daily post bag contains a small percentage of letters which require a trained engineer's reply, but it holds an enormous amount of correspondence needing the attention of a level-headed business man. In addition to the designing, estimating the cost of, and constructing new works, he has to control a large maintenance staff on the line and in his workshops. He has to deal, therefore, with staff matters, *i.e.*, questions of hours, wages and conditions of service of platelayers and other workmen; he has to design and maintain permanent way, bridges, signalling and telegraphs; he must deal with local authorities in a number of matters concerning the maintenance of roads, drains, and sewers; he has to understand parliamentary procedure with regard to new railways, and to be

fully conversant with Board of Trade rules and regulations. He often has to maintain canals and navigable rivers which have come under the control of the railway company, and in some cases docks and harbours. He must keep accounts of all expenditure on maintenance, renewals and new works, furnish statistics as to expenditure on capital and revenue account, and also as to the length of lines maintained by him. In many cases his line is affected by colliery workings causing subsidences, and he has to report to the directors on the statutory notices served by the colliery companies referring to their intention to work coal under the railway. In these duties he must, of course, be assisted by a staff, both at the head and district offices, and it is essential that he should be able to choose efficient assistants who can give him proper and necessary help.

An efficient staff can exist only where proper measures are taken to train it, and an efficient organisation cannot be obtained, nor will a department be properly staffed, unless it is possible to fill vacancies by suitable men who have been trained with a view to filling them. This means that the organisation should be designed, not only to obtain good results in ordinary working, but to provide a reserve of assistants ready and capable of stepping into the shoes of those above them. Further, the department should never be at the mercy of an indispensable man.

From the point of view of the staff, it is most desirable that there should be a clearly visible ladder up which the members may climb to the higher positions. At present there seems to be a long distance between the rungs. It is also not always easy for them to estimate how high they have climbed, nor who is in front of them and who behind. A great deal of impetus is given to a young man when he has a clear idea of his possible and probable future progress, He should know in what direction to exert his energy, what course is most likely to bring him early promotion, what are the essential matters he should master, what line of private study will be remunerative, in what way he can best bring his talents to the notice of his superiors. Frequently young engineers are spoilt by over attention to the theoretical side of their profession, and become excellent steel work designers, but neglect the acquisition of knowledge of the practical side of railway work. A college training often gives a man of mathematical mind a bent for calculations, abstruse and theoretical, which he carries out to an impossible number of places of decimals, without being struck by the fact that his fundamental assumptions cannot be verified within, perhaps, 10 per cent. Such a man in his early years does not realise what will be the result of concentrating his energies on figures instead of trying to equip himself for an executive post, and this failure is frequently partly due to circumstances preventing him from having a clear view of his possible avenue of advance. It is most necessary to impress on young engineers that high position is given to men who are able to control others, to deal with every-day practical matters in a business-like way, and to grasp the essentials of a problem quickly.

It is also necessary to point out to chief engineers that the efficiency of their departments depends on the opportunities given to the staff to make themselves proficient.

The first years of an engineer's career are usually spent in the design and on the construction of works, and the importance of these is fully realised. Such work, however, gives little scope for acquiring that special knowledge and experience which will fit him for such a position as that of district engineer, and as this is the half-way house between the bottom of the ladder and the summit of his ambitions, he will naturally want to feel his way thither and try first to discover the intermediate rungs. These are often missing, and this fact needs attention.

It should be arranged that every engineering assistant must, during his progress, hold certain positions and pursue a definite course which will ensure that he has an all-round experience. It should further be made a *sine quâ non* that he should hold the necessary qualifications by examination. Not only should he, as a matter of course, be qualified by membership of the Institution of Civil Engineers, but he should have been examined in subjects such as:—Rules and regulations of the company, law affecting railways in their relations with the general public, Board of Trade, public bodies, parliamentary procedure with regard to private Bills, principles of signalling, &c.

As regards the essential positions which he must hold, there would naturally be "alternative routes" to the higher posts, but the following are suggested:—Assistant to resident engineer on works; assistant in drawing-office; chief assistant to district engineer; resident engineer; assistant in charge of drawing-offices.

Each position should be graded, and its relative importance marked by the salary attached to it, and it should be understood by all, that on any of the graded posts becoming vacant they would be filled only by properly qualified men.

The successful competitor would know that he had progressed by one or more "rungs" on his upward journey, and would, moreover, know in what direction to strive in order to make further progress.

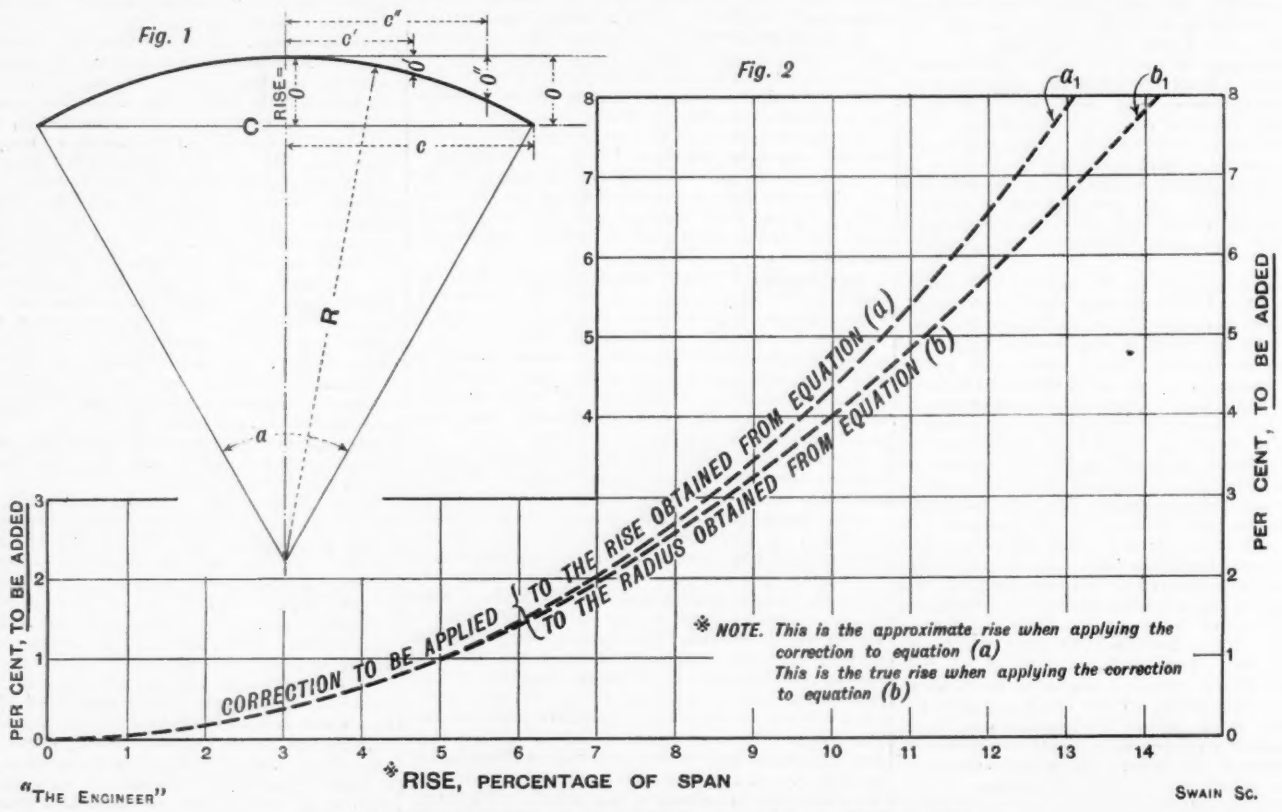
The improvement in the efficiency of the staff and in the status of the assistants would be marked, and the help that such a system would afford to the chief would be equally great.

The aim should be to form a competent but not large cadre of qualified assistants. A great amount of work in engineer's offices can be done by surveyors and draughtsmen. There are grave objections to keeping qualified men for years in subordinate and poorly paid positions, owing to there being no available promotion for them. Only a certain number of junior assistants should be engaged at the completion of their pupilage, and none should be taken on to the permanent staff unless there is a distinct vacancy for a qualified man. The remainder will either obtain berths in the Colonies or in India, or may possibly gravitate towards municipal or county surveyors' offices, or go into private practice.

The motto as regards the engineering staff should be "Small, but capable." A serious objection to keeping a number of older assistants in minor posts is that, although they may have been for years considered to be ineligible for promotion, they block the way of younger and more capable men by filling posts which would give essential and valuable experience to the latter, if they were able to obtain them. A man who is unfit for promotion will certainly prevent better men from getting certain necessary training, unless he is removed. If all minor posts were considered to be "rungs," and only climbers were allowed to occupy them, there would not be such congestion on the ladder.

One of the most disastrous effects which might follow the nationalisation of the railways, would be a possible extension of the vicious system of finding permanent billets for inefficients. The only way to economy is *viâ* efficiency, and every permanent appointment should be on the grounds of merit as proved by past success and supported by proper qualifications. The principle of "Get on or go under" is ruthless, but such ruthlessness is needed now, and will be needed more and more in every branch of the public service. The way to eradicate inefficients is to exercise a strict supervision, in order to prevent them from entering the service. The damage caused to the efficiency of a department by a number of middle-aged inefficients who are not good enough for promotion and cannot be removed is enormous.

To keep an efficient staff of assistants, they ought to have frequent changes, so as to widen and extend their knowledge and experience. If work is to be well done and the staff is small, the men must be efficient, but if the staff is unnecessarily large, it will harbour many who do not come up to the standard. No business concern ought to employ supernumeraries without a definite "job." During the war a greatly reduced staff has most efficiently carried on the work of the railways in every department. A great deal may be learnt from this fact.



Figs. 1 and 2—CALCULATION OF THE RADIUS AND RISE OF CIRCULAR ARCS

In conclusion, one would advise prospective engineers to enter a first-class railway engineer's office, if possible, as an articled pupil; but, unless there is a definite appointment to be secured on the conclusion of pupilage, the best advice is "Go abroad, and as soon as possible." If the individual is fortunate enough to see his way fairly clear before him on a British railway, his motto should be "Get control of others, executive power, management of correspondence, acquire a thorough knowledge of railway rules and working, and never forget that the most generally useful man, and not the most brilliantly scientific one, usually gets home first."

SIMPLE CALCULATIONS OF CIRCULAR ARCS.

Every engineer has from time to time, either in the field, workshop, or drawing-office, to deal with circular arcs of large radius, and he then finds that to get, by the ordinary rules, the correct ratio of radius to rise and of chord to length of arc requires a good many figures, and that the flatter the arc the more troublesome it is to arrive at a very close result.

The methods described below may be found useful, not only in such cases, but in many others which arise daily, and will, it is thought, prove generally preferable to the tables published in various forms.

(*a*) Dealing first with the *Radius and Rise of Curves.* To calculate the rise when the radius and chord are given, and the radius from the chord and rise,

Let C = chord of arc—see Fig 1.
c = half chord.
R = radius.
o = offset to tangent = rise,

Then $o = \frac{c^2}{2R}$ (*a*), and $R = \frac{c^2}{2o}$ (*b*) approximately.

This formula was devised by T. Baker in the early days of railways, and was largely used in laying out the older lines, but except for this purpose it has been comparatively little employed.

The objection to it is that the curve traced is really a parabola, but, in spite of this fact, for arcs up to about 4 deg., in which the rise is not more than 1 per cent. of the chord, the method will give results with an error not exceeding $^1/_{8000}$; with a given chord the error increases as the square of the rise. The diagram given in Fig. 2 shows by the height of the curves a_1, b_1 the correction to be applied for arcs over 4 deg., and with the aid of these curves the rule may be safely used for arcs up to 60 deg., in which the rise is about one-seventh of the chord. The application of the diagram may be illustrated by the following examples :—

Example I.—Arc 1000ft. radius, with a chord of 684.04ft., thus corresponding with a central angle—*a* on Fig. 1—of 40 deg. The half chord is 342.02ft., and by the above rule the offset *o*, or rise, would be $\frac{342.02^2}{2 \times 1000} = 58.475$ft., and $58.475 = 8.55$ per cent. of whole chord. Referring to the curve a_1 on Fig. 2, the correction corresponding to 8.55 per cent. is 3.1 per cent. —this is to be *added* in all cases—and $58.475 \times \frac{103.1}{100} = 60.287$ft. By trigonometry the rise is 60.306ft., and therefore the error is infinitesimal.

Example II.—In this we may take the chord and—true—rise as in Example I.; the half chord is therefore 342.02, and the rise *o* is 60.306. The approximate radius $= \frac{342.02^2}{2 \times 60.306} = 969.869$. Here the true rise is 8.82 per cent. of the chord, and the curve b_1 on Fig. 2 gives the correction to be added as 3.13 per cent. Then $969.869 \times \frac{103.13}{100} = 1000.23$. The true radius—see Example I.—is 1000, so the error is under $^1/_{4000}$ on this large arc. If the correction had been taken as 3.12 or 3.14 per cent., the radius would have been given as 1000.13ft. or 1000.32ft.—a very small error in either case.

Obviously any number of offsets, such as *o′ o″* on Fig. 1 may be calculated in the same manner as *o* in Example I., using distances *c′ c″*, &c. In the shop or drawing-office the curve may be drawn in with the aid of a batten or straight edge bent to follow the points so found.

(*b*) *Length of Circular Arcs.*—The following rule affords a convenient method of ascertaining very closely the length of a circular arc from the chord and rise. It is based on a graphic method given by Rankine, and corresponds to an approximate rule for the length of a catenary.

Referring to Fig. 1, length of arc = C plus $\frac{o^2 \times 8}{3C}$.

Example III.—Arc 1000ft. radius with a central angle of 4 deg. In this case the length of the chord will be 69.798ft., and the rise 0.6092ft., then $69.798 + \frac{0.6092^2 \times 8}{3 \times 69.798} = 69.812$. The true length by trigonometry is 69.813ft.

Example IV.—Take the arc dealt with in Example I., to find the length of the arc :—$684.04 + \frac{60.306^2 \times 8}{3 \times 684.04} = 698.076$, while the length found by trigonometry is 698.13ft., an inappreciable error.

(*c*) *Areas of Circular Segments.*—Another question which takes a good deal of figuring to answer correctly in the usual way is :—Given the chord and rise of a circular arc to find the area of the segment. Fig. 3 provides a simple and reliable method of arriving at the result. The rule is, as stated on the diagram, chord × rise × M, and the value of M is obtained by inspection from the diagram for all arcs in which the rise is between 0 and 50 per cent. of the chord. An example is given on the diagram.

T. J. R.

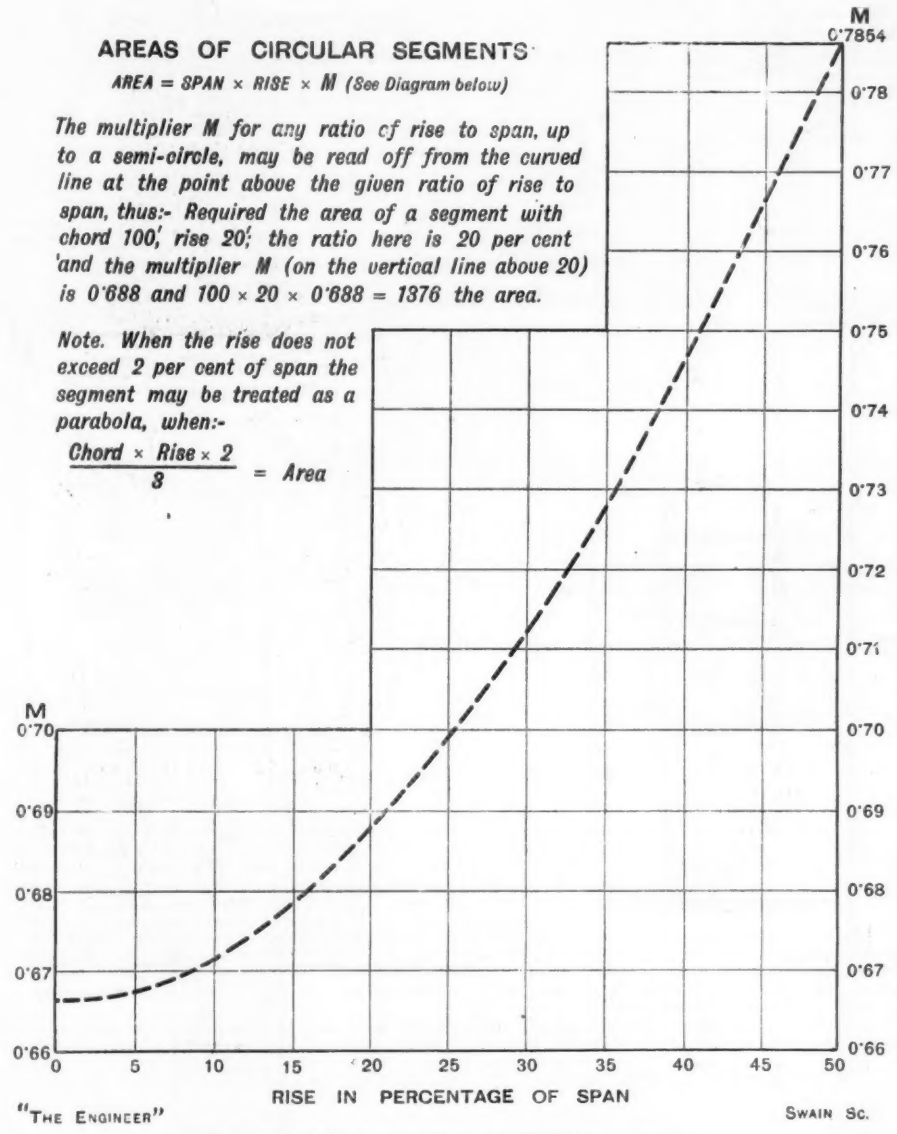

AREAS OF CIRCULAR SEGMENTS
AREA = SPAN × RISE × M (See Diagram below)
The multiplier M for any ratio of rise to span, up to a semi-circle, may be read off from the curved line at the point above the given ratio of rise to span, thus:- Required the area of a segment with chord 100′, rise 20′; the ratio here is 20 per cent and the multiplier M (on the vertical line above 20) is 0·688 and 100 × 20 × 0·688 = 1376 the area.
Note. When the rise does not exceed 2 per cent of span the segment may be treated as a parabola, when:-
Chord × Rise × 2 / 3 = Area
M
0·7854
0·78
0·77
0·76
0·75
0·74
0·73
0·72
0·71
0·70
0·69
0·68
0·67
0·66
0
5
10
15
20
25
30
35
40
45
50
RISE IN PERCENTAGE OF SPAN
"THE ENGINEER"
SWAIN Sc.

Fig. 3—CALCULATION OF AREAS OF CIRCULAR SEGMENTS

ENGINEERING PROJECTS IN LATIN-AMERICA.

A New Port in Peru.

For some years there has been under consideration what is known as the Matarani Port project, which aims at providing an additional and sorely needed port on the west coast of South America, with railway access from some especially rich mining centres of Peru. It now seems as if the scheme is likely to be proceeded with, and, in this case, there is no doubt a good opportunity for British contractors to bid will be afforded.

The site of the new port is at the foot of a ravine about twelve miles north of Mollendo, where there already exist a well-built port and harbour, which, however, in a very few years will have become taxed to their utmost capacity for handling the traffic offering. Although Mollendo Port, the property of the powerful Peruvian Corporation, and the port for its Southern Railway, has only recently been improved, it is not likely to be able ever to handle more than 300,000 tons of cargo annually. That is the considered opinion of several distinguished engineers who have studied the subject on the spot. The anchorage at Mollendo is an open, and, therefore—upon these coasts—a dangerous one, all landing operations having to be suspended during the frequent heavy swells that afflict this coastal region of South America. On the other hand, the small bay at Matarani is better, but still not completely, protected from both winds and swell, while it has water close in shore, ranging from eleven to fifteen fathoms in depth. If the Government of Peru should finally resolve to go on with the Matarani project, there is little question that injury would be done to the interests of the Peruvian Corporation, which would thus witness the practical waste of the sum of £120,000, that, within recent months, has been expended upon further improving the facilities of Mollendo. In all probability this fact would not deter the Peruvian Administration from proceeding with its scheme if it seemed good to it so to do, and, indeed, it would possess every right to carry it out. But then comes the consideration of feeding the new port with traffic of interior origin as well as providing it with overseas cargoes. To render the Matarani port of any value to the extensive system of railway controlled by the Peruvian Corporation, namely, the Southern lines, it would become necessary to expend a further sum of at least £500,000 on bringing the railway to Matarani, and, in addition, the Administration would have to bear the burden of a partially useless port and wharf at Mollendo.

The heaviest cost in connection with this undertaking would be in the reconstruction of the Southern Railway's lines from the port of Matarani to Joya, the most convenient point on the existing system, a distance of 75 kiloms. The object in adopting the idea of this new construction is to lessen the distance between Arequipa and the coast. The whole saving would not, however, amount to more than 25 kiloms., while the projected cost for this part of the scheme alone is put at £300,000 out of the total cost of £500,000. Further, a complete installation of public works, including a water and a sewage works, would be necessary. That part of the scheme would call for an outlay of £80,000. The decision of the Peruvian Government will be awaited with no small amount of interest.

Bolivian Railways.

July 4th was the date upon which it had been determined officially to inaugurate the new line of railway running between Oruro and Cochabamba, in Bolivia. The undertaking has proved a task of immense difficulty, as much on account of the stupendous engineering problems that have called for solution as for the provision of the funds necessary for the purpose. For several years past a section of the line has been in operation, but the inconvenience endured by passengers for Cochabamba by the compulsory coach or mule journey over the last part of the journey, nearly 80 miles, has rendered the line anything but popular. Besides being in a very rich copper-producing district, Cochabamba lies in the centre of a fine agricultural country, which will now be able to develop its resources to an unlimited extent. Since the present Administration in Bolivia, under the Presidency of Señor Montes, came into power, over 1000 kiloms. of new railway line have been opened to public use, while, in addition, 600 kiloms. are under construction. This is deemed to establish a record in a hitherto almost railway-less country, under any presidential government. Between 1906 and 1917 the following new lines have been added to the Bolivian railway system :—Oruro-Cochabamba, 203 kiloms.; Oruro-Viacha, 202; Viacha-La Paz, 29; Roi Mulato-Potosí, 174; Uyúni-Atocha, 90; Machacamarca, 40; Charaña-La Paz, 233; Corococo, 8; Kenko, 8; Quillacollo-Cochabamba, 18; and Cochabamba-Arani, 60, or a total of 1605 kiloms. of new line. That in construction includes :—Atocha-Tupiza, 104; Tupiza-La Quiaca, 100; Uncia, 64; La Paz-Yungas, 125, and Potosí-Sucre, 178 kiloms., a total of 571.

COAL AND ASH PLANT AT THE OSAKA ELECTRIC WORKS.

By GEORGE FREDERICK ZIMMER, A.M. Inst. C.E.

The Osaka Electric Lighting Company may justly be proud of one of the most complete installations, which has been designed and supplied by Babcock and Wilcox. The distinguishing feature of the plant is its immunity from interruption through breakdowns of the handling machinery, an essential feature which every electric lighting plant should—but very rarely does—possess.

We shall see that at all points, except the receiving point for the coal, there are alternative methods to fall back upon for handling coal or ashes in the event of a breakdown of the conveying machinery, although this machinery is of a type which rarely gives trouble. It might be argued that if the receiving terminal should break down all precautions in duplicating the other means of transport would be useless; but this is not the case, for the open coal store will accommodate about 3000 tons of coal, which is a sufficient safeguard to render the plant independent of its receiving end for some time.

A good deal of the general lay-out of the installation may be gleaned from the drawing on page 116, this being a general elevation and plan.

At the right-hand side of the plant is the coal receiving terminal on the bank of the river Ajikawa. The automatic railway, which is the second link in the chain, bridges a road, and immediately beyond this begins the main coal store, which measures 110ft. by about 65ft., and which will hold about 3000 tons of coal, an amount equal to the requirements of the plant for ten to fourteen days. The automatic railway then crosses a creek, and enters the coal receiving annexe of the power-house at the extreme left of the drawing; close to this, and between this annexe and the power-house is the ash collecting station, and finally the power-house proper. The capacity of the coal-handling plant is 40 to 50 tons per hour.

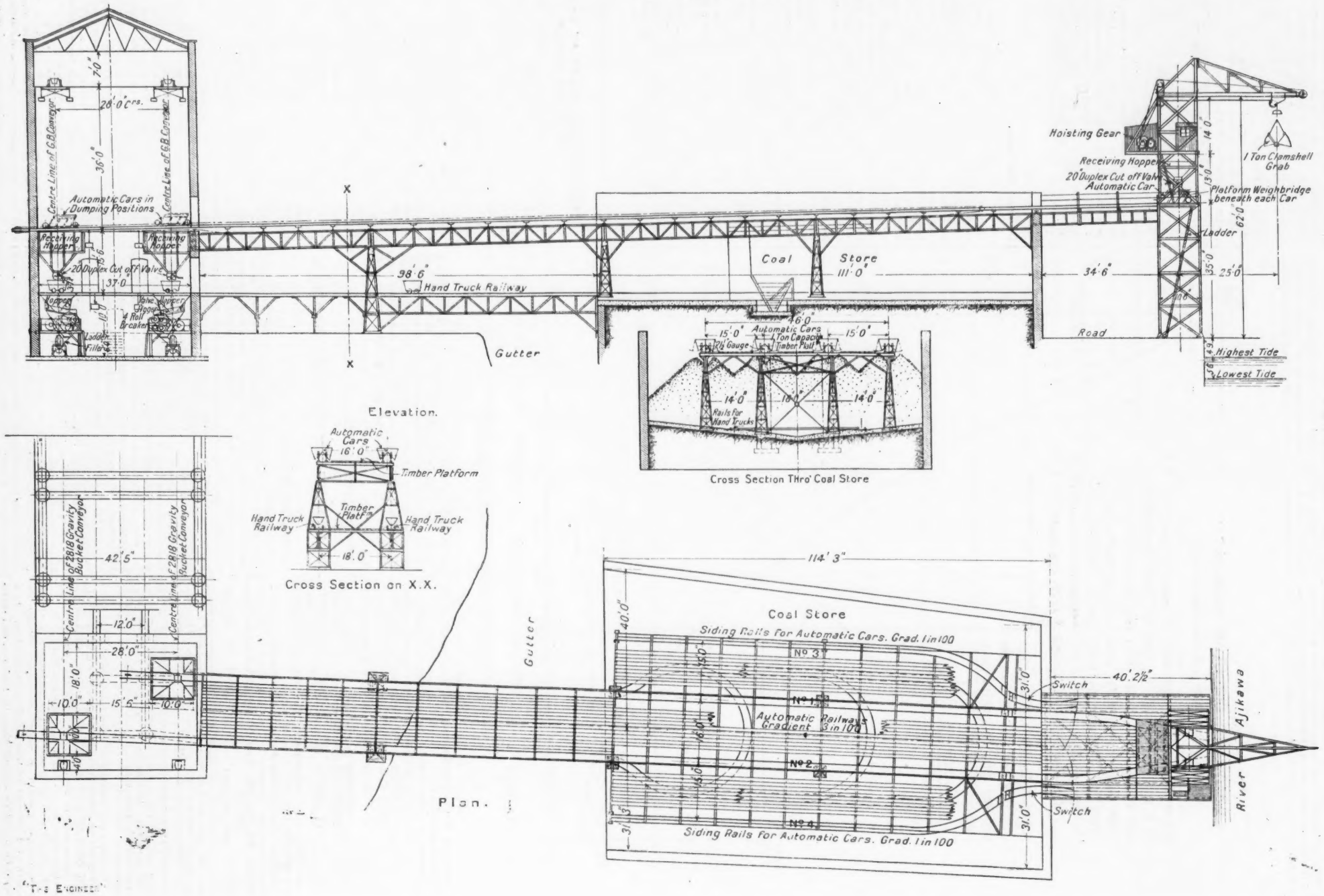
For the sake of convenience the subject has been here divided under three heads : (1) The receiving tower, with the automatic railway; (2) the gravity bucket conveyor; (3) the handling of the ashes.

(1) *The Receiving Tower, with the Automatic Railway.*—This part of the installation consists of one Babcock and Wilcox electric cantilever or transporter crane carrying a patented clam-shell grab of one ton capacity, and operating at the rate of 40 to 50 tons per hour. The attendant is housed in a cabin on the inner or land side of the receiving tower, where, by means of a series of

COAL AND ASH PLANT AT THE OSAKA ELECTRIC WORKS

BABCOCK AND WILCOX, LIMITED, LONDON, ENGINEERS

(*For description see page* 115)



"THE ENGINEER"

SWAIN Sc.

levers, he controls all the motions of the crane. The coal is picked up from a barge by the grab, run inwards until vertically over the receiving hopper and discharged there. The electric motor driving the crane is a three-phase, 60 cycle machine of 80 brake]horse-power.

The automatic railway consists of two lines extending —parallel to each other—from under the crane receiving hopper to two delivery hoppers over the conveyors, which in their turn deliver to the boiler-house, each railway having a capacity of 40 to 50 tons per hour; one only need be used, and the other may be used as a stand-by. The tracks of these automatic railways are elevated and are carried on piers at a sufficient height to allow of coal being stored underneath to a depth of 20ft., and also to provide headroom for the two receiving hoppers and pair of coal-breakers over each gravity bucket conveyor.

The energy communicated to the counterweight instantly reacts on the now empty truck, and pushes it rapidly back up the incline to the loading point to be refilled.

When the coal is not wanted immediately, the automatic trucks discharge into the coal store, which occupies a large area between the receiving terminal and the power-house; the "barrier" and tripper are adjusted at any pre-arranged part of the track where it traverses the store, and the trucks are thus similarly discharged and returned from this distance with the same accuracy, as the stored energy is always proportional to the velocity of the truck and the distance of the latter from the starting point.

It will be observed from the drawing, on page 116, that a supplementary system of two tracks with switches is provided over the coal store, enabling it to be filled up to the uttermost capacity, as shown on the cross section.

when small, by missing the breakers, direct to the conveyors. The breakers are driven by two 15 brake horse-power electric motors. The conveyors are 18in. wide and 28in. pitch, each bucket being 24in. long and 12in. deep, and holding 2 cubic feet. The speed of travel is about 50ft. per minute.

The coal is ultimately fed from the overhead bunker to the boilers through Avery automatic weighing and recording coal scales. By this method, not only is the total consumption of coal recorded, but also the quantity doled out to each boiler, and as the total weight of coal discharged by the crane into the station has previously been recorded, these quantities can easily be compared and checked. The Avery coal scales are strictly automatic in their action and require no operating power.

(3) *The Handling of the Ashes.*—The ashes are collected

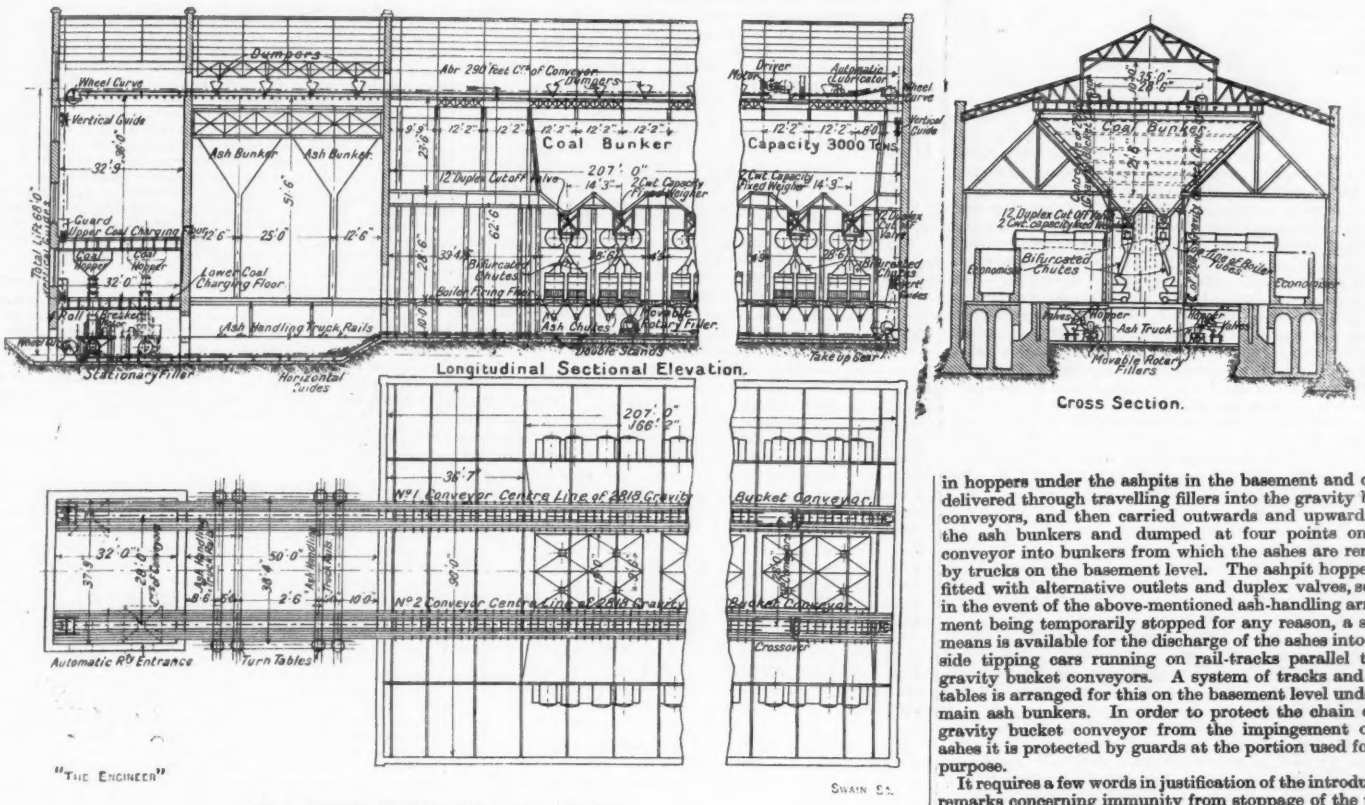


Fig. 1—BOILER HOUSE AND COAL BUNKERS

in hoppers under the ashpits in the basement and can be delivered through travelling fillers into the gravity bucket conveyors, and then carried outwards and upwards over the ash bunkers and dumped at four points on each conveyor into bunkers from which the ashes are removed by trucks on the basement level. The ashpit hoppers are fitted with alternative outlets and duplex valves, so that in the event of the above-mentioned ash-handling arrangement being temporarily stopped for any reason, a second means is available for the discharge of the ashes into small side tipping cars running on rail-tracks parallel to the gravity bucket conveyors. A system of tracks and turntables is arranged for this on the basement level under the main ash bunkers. In order to protect the chain of the gravity bucket conveyor from the impingement of the ashes it is protected by guards at the portion used for this purpose.

It requires a few words in justification of the introductory remarks concerning immunity from stoppage of the plant. This is secured either by the different units for handling the material being in duplicate, or by auxiliary methods of handling being provided. Thus, for instance, the automatic railway is in duplicate, each unit being capable of handling 40 to 50 tons per hour. The gravity bucket conveyor is likewise in duplicate, each conveyor being of a corresponding capacity to the automatic railway. The ash handling may be accomplished from each range of boilers, either by one of the gravity bucket conveyors or by the hoppered trucks and rail system, as the ashes can be discharged with the same facility into either. This still leaves the conveying of the coal from the stock heap to the receiving hopper over the breaker *viâ* which the coal enters the filling devices of the gravity bucket conveyor. This part of the process is not performed by mechanical means, and it may, therefore, appear at first sight that the plant lacks in this respect in modern completeness. It may, however, be argued that this

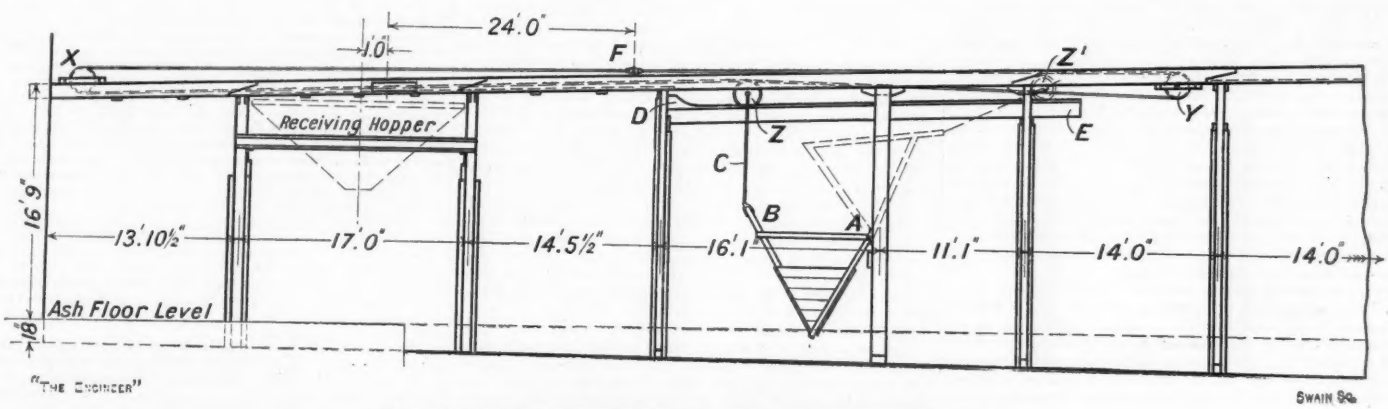


Fig. 2—AUTOMATIC TRUCK DISCHARGING AND RETURNING ARRANGEMENT

The process of delivering coal by the automatic trucks is simple and rapid. The outlets of the receiving hopper on the crane are fitted with 20in. duplex coal valves, operated by simple levers, and capable of quickly charging the 20-cwt. automatic trucks, the terminal position of which is under these valves. The automatic trucks rest at these points on Avery's weighbridges, which automatically weigh and record the load of coal placed in each truck, and the total weight of coal delivered in any given time can thereby be accurately and quickly ascertained.

When a truck is charged and weighed it is pushed forward by hand or by a small hydraulic ram, and thereby started on its journey along the rail-track which, with a falling gradient of 3 per cent., enables the truck quickly to accelerate its speed, so that when it reaches the extreme end of the track over the gravity bucket receiving hopper, where it discharges automatically, the energy stored in the truck and load is sufficient to provide power to return the empty truck to the loading point. This energy is taken advantage of by providing a "barrier" near the discharging point which is met by a "pick-up" or cam—forming part of the truck—which is carried forward with it for a short distance—see Fig. 2. As this "barrier" is connected by a steel wire rope system to a counterweight, the latter is raised in exact proportion to the energy stored in the truck. At this instant the release lever on the automatic truck comes in contact with a tripper, which instantly frees the opening sides of the truck, and the contents shoot out into the hopper. The automatic cars on these supplementary outer tracks are pushed by hand and discharged, as required, but this manual work is only necessary when the store is to be filled to the uttermost; these auxiliary tracks have a gradient of 1 per cent. to facilitate the moving of the loaded trucks.

In discharging coal from the coal store to the overhead bunkers in the boiler-house, semi-circular and parallel lines of track are employed on the floor of the dump. Side tipping cars are used, loaded up by hand in this case, and taken to the receiving hoppers over the breakers and there tipped, a regular supply being delivered into the hoppers, through the breakers, and thence into the gravity bucket conveyors.

(2) *The Gravity Bucket Conveyors*—see Fig. 1.—This part of the installation consists of two gravity bucket conveyors, each of a capacity of from 40 to 50 tons per hour, so that here also only one need be used at a time; they are arranged parallel to each other throughout a horizontal distance of about 350ft., each lifting the coal through a vertical distance of about 67ft., and delivering the same at twelve points, into an overhead bunker of 3000 tons capacity over the boilers. These conveyors are driven by two electric motors, each of 10 horse-power. The conveyors are fed with coal either direct from the automatic trucks *viâ* the receiving hopper, or from the coal store by the side tipping car system. Two large duplex coal valves control the supply of coal from the receiving hoppers to the gravity bucket conveyors by first passing the coal, when large, through breakers, and

apparent shortcoming is insignificant, being governed by local conditions. In the first place, the coal arrives in barges and not in large vessels, so that with the exceptionally large bunkers over the boilers, holding 3000 tons, there may be no occasion to use the dumping plant, except at rare intervals. In the second place, labour conditions in Japan are vastly different from ours, and the occasional employment of a gang of men for the transference from stock to the receiving hoppers is not an item which materially affects the economy of the plant.

Concerning the automatic railway, it is a pity that this useful device is so little employed in this country, while in the land of its birth, the United States, it is much in evidence.

The only objection to which this system is open is the fact

that it discharges its load rather violently when the dumping place is empty, and the coal has therefore to drop a long way, and it is urged that this is responsible for unnecessary breakage; but in gasworks and power stations where, as a rule, small coal is used, this objection hardly applies. However this may be, the fact that the system is too little known in this country—there are only six installations in use—justifies a little closer investigation. One of the attractions of this ingenious system is that it requires no driving power whatever, and only one man is necessary to attend the plant at the loading terminus, and it is even possible for him to attend to two installations if close together, as in this particular case. The limitation is a run of 500ft. to 600ft., and it is, perhaps, at its best for distances of 400ft. to 500ft., and for a capacity of 50 to 60 tons per hour. The cars, after filling, run, as we have seen, down the track, deposit their loads at any predetermined point, and return to be refilled absolutely without any expenditure of driving power, except that of their own creation. The counterbalance weight which, like an accumulator, receives and pays out the inertia of the descending car, is shown in the elevation on page 116, but its function will be better understood by reference to diagram Fig. 2, which shows a similar appliance to a larger scale. The triangular weight is hinged at A, while the corner B is raised by an iron connecting-rod C, attached to the centre of a pair of rollers Z, which run on a short path D E when attached temporarily to the descending load of the trucks by a wire cable.

The apparatus works as follows:—X Y are the two terminals of the wire cable which manipulates the railway, F is the "barrier" with which the descending truck engages. This "barrier" is carried by the truck for a distance of about 24ft., when the tripper opens the truck door at a point 7ft. before the centre of the receiving hopper is reached in order to get a clear delivery into the hopper. The cable which manipulates the balance-weight, and which passes over the terminals X and Y, makes also at each end one half revolution round roller Z, while the extreme ends of the cable are fixed at the points D and E, that is to say, one end of the cable is fixed at E, passes thence over roller Z to roller Y, along the top strand to X, back again over roller Z, and to the other fixed point D. Whilst the "barrier" F is now dragged along the line the roller Z travels from the position shown in full line on the drawing to the position Z^1, shown in dotted lines. It will be understood that when the impact takes place between the "barrier" and the car the hanging weight will offer no resistance, as it is supported by the rod C and the rail-track above, and the act of appreciably lifting the weight does not begin until the cable has travelled for some distance. The roller Z consists of two ordinary truck wheels about 2in. or 3in. apart, the space between the flanges of the wheels being filled in by a drum round which both ends of the cable are passed The truck has two large side doors which are fastened to each other, so that they must both open together as soon as they are unlatched by the tripper.

The cost of the handling machinery, exclusive of structural work, freight, and erection, was about £7000.

Osaka, or as it is sometimes spelt Ozaka, is one of the three largest cities of Japan, is in the Province of Settsu, and is situated at the head of the gulf of the same name, and on both banks of the river Yodogawa. In 1908 it had a population of 1,226,590. It is an important railway centre, also a military headquarters with garrison and arsenal; the port was opened to foreign trade in 1868.

TWO NEW HORIZONTAL BORING MACHINES.

On page 120 are given illustrations of two horizontal boring, milling and drilling machines, with the latest improvements, made by the firm of Geo. Richards and Co., Limited, Broadheath, Manchester. The machine shown in the upper view is of the sliding spindle type, and is made in two sizes with spindles 3in. and 3½in diameter respectively. The spindle of the machine illustrated is 3in. diameter, has a traverse of 24in., is bored No. 5 Morse taper, and has 16 hand and self-acting feeds. A twelve-speed gear box and single pulley drive are provided, or the machine may be arranged for a direct motor drive by a constant speed motor. Rapid power traverses to the table in both directions are also fitted, giving 16 rates of feed, as well as to the spindle frame in a vertical direction. It will be noted that all the hand wheels and levers are grouped together, so as to be within easy reach of the operator. The centre of the spindle is adjustable from 3½in. to 22in. above the top of the table, and from 7½in. to 26in. above the sliding table. The top revolving table is 30in. square, and the sliding table 42in. by 30in. The table has an automatic longitudinal traverse of 34in., and automatic cross traverse of 31in. The bed of the machine is 6ft. 4in. long from the face to the upright, and the maximum distance from the face-plate to the boring stay is 5ft. 3in. The spindle frame is counterbalanced and has two speed making 24 spindle speeds altogether. The lower view shows a new size of Pearn-Richards' combined surfacing, boring, milling, and drilling machine, capable of facing and edging flanges up to 18in. diameter. This machine is the smallest size made by the above firm. The top table is 21in. square, and the plain table 30in. by 21in. The table has an automatic longitudinal traverse of 39in. with the boring stay removed and automatic cross traverse of 22in. The spindle centre is adjustable from 6in. to 22in. above the plain table, and from 2½in. to 18½in. above the top table. The bed is 5ft. 6in. long from the face to the upright. The boring stay will take bars up to 2½in. diameter, and the maximum distance between the boring bar socket on the facing head and the boring stay is 4ft. The machine has 32 speeds, and there are four rates of feed to the table longitudinally and transversely, as well as to the spindle frame vertically. Rapid power traverses are also provided to these motions. The machine has a single pulley drive and speed gear box.

It may not be generally known that the first Atlantic cable was used in the construction of the Albert Bridge across the Thames in 1873. In 1884 the cable was replaced by steel bars.

TRADE BETWEEN THE UNITED KINGDOM AND CANADA.

The following notice appeared in the *Board of Trade Journal* for the 9th inst.:—The Imperial Trade Correspondent at Winnipeg (Mr. W. J. Healy) reports, under date 30th June, that, at a recent meeting of the Winnipeg Board of Trade (*i.e.*, Chamber of Commerce), a new Standing Committee was appointed with the object of promoting trade between the United Kingdom and Canada. This Committee, which is to be known as the Imperial Trade Committee of the Winnipeg Board of Trade, is prepared not only to answer all questions by British manufacturers bearing on the trade within the Empire, but to receive, and have properly displayed, samples from any British manufacturer. By this means, it is thought, importers in Western Canada will have an opportunity of handling British made goods which are suitable for that territory. Samples submitted can usually be sold, and the proceeds, less a small commission to cover incidental expenses, remitted to the exporter. The Committee will also endeavour to establish connections between the importer and manufacturer, or the importer and agent.

Communications from the British firms should be addressed to the Secretary, Imperial Trade Committee of the Winnipeg Board of Trade, Winnipeg.

BOOKS OF REFERENCE.

The first edition of the *Flying Book*—or the Aviation World "Who's Who," Industrial Directory and *Vade Mecum*—was published in 1914. It was evidently the intention that it should be revised yearly, but owing to the war it has been found impossible to produce the second edition till the present time. The new volume is divided into three parts, the first of which contains short articles on "Aeroplanes in War," "Naval Aeronautics," "Aeroplane Design and Construction," "How to Control an Aeroplane," "Aero Engines," "Airships," and "Kite Balloons." Some forty pages are then devoted to a list of modern aeroplanes, with brief descriptions and illustrations of each. Then follows an historical section containing illustrated descriptions of machines not now in use, and this in its turn is succeeded by a chapter on aero engines, many of the types being illustrated in outline. The section ends with a list of records. Part II. contains, first of all, particulars of the various aeronautical organisations, an industrial directory of British, American, French and Italian firms, and "Who's Who in Aviation." Part III. contains, first of all, particulars concerning naval and military aviation. Then there is a long list of honours conferred on airmen during 1916, and it is followed by a list of Zeppelin raids, an aeronautical diary of 1916, a list of aeronautical publications, a glossary of aviation terms, and a selection of useful tables. The book is published by Longmans, Green and Co., price 3s. 6d. net.

The 1917 edition of *London Shipping* has just reached us. It is, as our readers are aware, a useful little book, giving lists of shipowners trading to and from London, and of ship brokers; as well as information regarding the Port of London Authority, the various London Docks, including graving docks; railway facilities, Lloyd's Register, the British Corporation, the Bureau Veritas, the Institution of Naval Architects, Marine Surveyors, Insurance Companies, the Admiralty, the Board of Trade, the Trinity House, Consulates, the London Chamber of Commerce, various societies, associations, &c. It is published at the *Journal of Commerce* office, 37, Walbrook, London, E.C. 4, at the price of 1s., or by post 1s. 3d.

BRASS SCRAP.

The following letter has been sent by the Ministry of Munitions to firms desiring supplies of brass scrap arising from the manufacture of munitions:—

8, Northumberland-avenue,
London, W.C. 2.

Gentlemen,—Regarding your future requirements of scrap metals, will you please note that in future you will not be permitted to obtain supplies of brass turnings or borings of any kind or brass scrap arising from the manufacture of munitions of war, from any source whatever except the Ministry. All enquiries regarding these must be sent to the above address and under reference A.M.2/S.

On receipt of your requisition, together with particulars of contracts against which you would require to use the material, we will, provided these are found to be in order, make you an allocation as early as possible.

In the event of your having any complaint to make either as to shortage in weight, or to the quality of the scrap or swarf, notification must be made by you to the Consignor within three days after receipt of delivery, and all claims must be settled direct between the Consignor and the Consignee, as the Ministry will accept no responsibility whatever in regard to these.

No swarf or scrap must be smelted until all claims regarding same have been adjusted, and the Consignor must be given the option of seeing the material re-weighed before the consignment in dispute is broken into, and the weight thus agreed shall be the weight invoiced to the Ministry by the Consignor.

I am, Gentlemen,
Your obedient Servant,
LEONARD W. LLEWELYN,
Director of Materials.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COAL ECONOMY.

Sir,—I have read with interest Mr. Casmey's letter of the 13th July on the above subject, and also his reply in your issue of August 3rd to "Lancastrian's" comments on the same. That there must be a tremendous waste of coal in the country owing to inefficient combustion anyone who has made a close study of the question is bound to admit; but there are several conclusions to which Mr. Casmey has come which are open to grave doubt. The statement that during a smoky period 10 per cent. of the coal fed to the fires is escaping from the chimney is such a one, and does not correspond with my own experience in connection with the working of approximately 400 boilers used by a large manufacturing association, the plant of which is subject to very fluctuating loads, nor yet with that of other experimenters who have gone carefully into the question. In the Bulletin de la Société Industrielle de Mulhouse, 1868–1869, are given the results of MM. Shuerer-Kestner and Meunier, who passed flue gas through asbestos and found that with good fires and draught, and an air supply of 257 cubic feet per lb. of coal, only one-half of one per cent. of carbon in the coal was lost as smoke particles, and in a second trial with poor fire and draught, and only 118 cubic feet of air per lb. of coal, the deposited carbon was only one per cent. of the total contained in the coal. Mr. J. C. Hoadley, of New York, experimenting in 1886, by passing flue gases from a boiler through a muslin strainer in a vessel of water, evaporating the water, and weighing the residue after a week's working, found that the solid matter, which was of a grey colour, and not likely to be all carbon, amounted to one-third of one per cent. of the total used. I have in mind here in Lancashire two boiler plants using bituminous slack, which were notorious for producing black smoke, and from which excellent CO_2 results were regularly obtained by means of CO_2 recorders, and which compared well in cost per 1000 gallons evaporated with normal plants using the same fuel. The economic results certainly did not differ by anything like 10 per cent. The results of working were obtained by means of continuous records under expert supervision. Mr. Casmey's assertion that a greater evaporation can be obtained from a Lancashire boiler by using shorter grates than is usual, neglects things which are of vital importance, so far as results are concerned. There are, at any rate in Lancashire and Yorkshire, both fast and slow burning fuels, which means that a time element is introduced when dealing with their consumption; this time element necessitating large grates to raise the amount of steam required.

It is also an established fact that the possible consumption on a boiler grate does not vary directly as the draught available, but in a decreasing ratio, from that which best suits the type of fuel, when used with a higher draught, however obtained. There are plenty of plants working with low fuel consumption per square foot of grate in which Mr. Casmey's suggestions would doubtless be beneficial, but to apply them generally would not be practical. It would be of general interest if Mr. Casmey would indicate by what means the 10 per cent. loss from black smoke was recorded.

Manchester, August 8th. W. Townsend.

Sir,—If Mr. Casmey can really tell by a mere glance at some mythical continuous-reading instrument what the percentage of CO_2 in his boiler flue may be at any particular moment—a statement which I will ask him to forgive me for receiving with caution, in the light of previous experience—we are, in fact, getting nearer the solution of our problem. As that solution is to result in an annual saving of some fifty millions of tons of coal—and steamship economy is not included even then, I imagine—not to mention the deliverance from anything up to 75 tons of undigested carbon delivered, according to a recent estimate, per square mile per month in such favoured localities as Bolton and elsewhere, why then the point seems worth rather more than casual mention.

In the meantime, the blame for this grievous failure in our national economy will have to be shouldered as usual, I suppose, by the wrong man—my friend, the stoker. Good stoking will, I admit and have proved, go a long way, but there are limits. Even the best of stokers cannot always, or even often, tell when there is a hole in his fire, with the consequent inrush of cold air, lowered temperatures, and all the rest of it, unless, indeed, he goes inside to look—an alternative possibility to Mr. Casmey's chemist in the flue. The fault of admitting too much air, on the assumption that one cannot have too much of a good thing, is undeniably prevalent; but, at the best, the correct air admission is no more than guesswork under present conditions, and a CO_2 percentage as low as 7 or 8 is, in all fairness, not such bad work even with reasonably willing and intelligent collaboration on the part of one's staff.

Since the CO_2 constituent is such an undeniable criterion of combustion, as we have always been taught to believe, why, in the name of common sense, should we go on guessing at it if Mr. Casmey, alone among engineers, has an indicator calibrated in £ s. d. to tell him when coal and air are combining in harmonious proportion? Steam-raiser.

August 8th.

AN EARLY STEAMBOAT.

Sir,—As a reader of your magazine, I feel greatly indebted to you for obtaining from Mr. Arthur Johnson a photograph of the "Rastrick Steamboat" for publication.

In your issue of July 27th, you say that "Trevithick could not be regarded as a pioneer" of the steamboat; I think pages 321 to 326, Vol. I., of his "Life," prove conclusively that Trevithick was *the* pioneer of this branch of engineering. On page 326 we read:—"This account of a 60 or 70-ton barge, driven by a high-pressure steam puffer engine, having a cylinder 10in. in diameter, at a speed about seven miles an hour, the float-boards going at fifteen miles an hour, proves that had Lord Melville spared five minutes out of that week to keep his appointment with Trevithick, the first steam fire-ship would have dated from 1804; for within three months from that time he had driven a barge at a speed of seven miles an hour by an engine that had been constructed for another purpose, and was adapted to the steamboat on the spur of the moment by a crank shaft across the deck, having at each end a paddle-wheel, with six paddle-boards 14in. deep by 2ft. 2in. long.

"Trevithick's steamboat was an ordinary canal barge, into which one of his steam engines had been placed as goods for conveyance to Manchester from Coalbrookdale, as mentioned in his note of October 5th, 1804, and January 10th, 1805. The fact came under the notice of the Prime Minister, and the makers of the engine were among the best known manufacturers of the day, yet no one has recorded that Trevithick constructed this first practical steamboat."

The photograph you published is of more than passing interest to me, as John Urpeth Rastrick was my great-uncle. I regret, however, that I can throw no further light on the "steamboat drawing." Arthur Lee.

London, August 2nd.

Sir,—Regarding notice in your issue of July 27th, with drawing of an early steamboat signed by John U. Rastrick, and dated March 27th, 1813, this might be the engine referred to by Richard Trevithick in his letter to Mr. Giddy, dated January 10th, 1805—see "Life of Richard Trevithick," Vol. I., page 324. Jas. H. Anderson.

Glasgow, August 2nd.

Russian Exhibition.—An exhibition illustrating the chief features of Russia's economic life was opened at the Central Hall, Westminster, on the 7th inst., and is to continue until the 18th inst. The exhibition includes a representative collection of minerals from the Urals, and there are lectures every evening, at 8 p.m., on such subjects as agriculture, forestry, mineral resources, industries and foreign trade.

RAILWAY MATTERS.

The latest railway officer to be called to the assistance of the Government is Mr. R. F. Dunnell, the secretary and solicitor to the North-Eastern Railway, who has been appointed temporary and additional secretary to the Admiralty. Mr. Alan Garrett Anderson, who has been made Controller in place of Sir Eric Geddes, is a director of the Midland Railway.

In order to secure the fullest possible utilisation of its rolling-stock a special transport bureau has been set up in Sweden, the duties of which will be to allocate cars to traders. Special arrangements have also been made to ensure the best use being made of the locomotive stock, and to this end a system of close co-operation between the mechanical and operating departments has been introduced.

The Canadian Minister of Railways has recently reported to the Dominion Parliament that by combining the respective railways of the Grand Trunk Pacific and the Canadian Northern, from Imrie to Resplendent, a distance of 207 miles, through the Yellowhead Pass, 205 miles of railway have been taken up and sent to France. Of the combined line 128 miles will be on the Canadian Northern route.

When steel passenger coaches were introduced on to the railways of the United States they undoubtedly had some effect in securing competitive traffic, but their use has now become so general that the advantage, from the advertisement point of view, has disappeared. The first cost of steel cars is higher, and the available data, though meagre, indicates that the cost of maintenance is considerably greater than for wooden cars.

It is announced that the railwaymen's war bonus of 15s. per week for men and 7s. 6d. for youths is in future to be reckoned as wages. This will be of benefit to the men in that payments for overtime and Sunday duty will be calculated at the higher rate that includes the bonus amount. It is expected that the same concession will be made to the shopmen. This is the fifth increase in pay made to the railwaymen since the war commenced, three years ago.

According to a bulletin of the special Committee on the Relations of Railway Operation to Legislation in the United States, only three wooden cars for passenger train service were built during the year 1916, and only ten were under construction on January 1st, 1917. The building of wooden cars for passenger service has practically ceased, and those now in service are being gradually withdrawn. Nearly 9000 have been withdrawn since January 1st, 1912, and 2213 were withdrawn during last year.

Paragraphs have recently appeared in the daily Press as to a further reduction in train services. These have not, we have reason to believe, been issued on the authority of the Railway Executive Committee, but may be regarded as an intelligent anticipation of what is likely to happen after the holiday season has come to an end. There have not, as we intimated on page 54 of our issue of July 20th, been any "summer train services" this year, and so it is fair to assume that if the spring train services have been sufficient to carry the traffic lately there is room for a reduction when the present pressure has ceased.

During the last three years there have been Board of Trade reports on accidents issued which go to show that the London and North-Western, Midland, Caledonian and North British companies now calculate the weight of their passenger trains by the actual weight of the coaches, and that the Great Western and the Great Northern by the number of wheels. Other companies may, of course, have followed either of these examples, but there has been no report issued that has revealed any such change. The former method, and that still in force on the minor lines, is to count the weight by the number of vehicles, a four-wheeled coach being reckoned as one, a six-wheeled coach as one and a-half, and a bogie vehicle as two. Where the weights are used the weight is to be found on the buffer beam.

In the Dominion House of Commons, on the 1st inst., the Canadian Minister of Finance announced that the Government was adopting the recommendation of the majority report on Canadian Railways—noted in our issue of July 27th—and had arranged to take over the Canadian Northern Railway. The financial embarrassment of the Canadian Northern and the Grand Trunk Pacific was such that Government assistance was necessary if the systems were to continue to serve the public as solvent concerns; otherwise, a receivership and the default of bonds would ensue. In view of the large financial assistance already given to these companies the Government considered that if the public must continue to do the financing of them the public must have control of the railroads. Regarding the Grand Trunk Pacific, the Government proposed to advance to the company 7,500,000 dols. at 6 per cent., taking control of the directorate, and with a view to the ultimate acquisition of the system as public property. This was a matter that could not be so readily disposed of as was the Canadian Northern.

Tentative arrangements have been made in New York for financing a new railway in Northern Peru, which, when completed, should open up one of the richest sections of South America. The line as projected will be about 250 miles long, and will be another link in the Pan-American transcontinental system. The road will cross the lowest depression of the Andes, and on the Pacific it will have what is said to be the best seaport in South America, at Payta. Thence it will extend inland, traversing the richest regions of the Americas. The total cost of construction will amount to about £4,000,000. An additional £2,000,000 will be required for development purposes. The line, it is reported, will be comparatively easy to construct, and there should be only one bridge of importance, that which will cross the Amazon River. The bridge, with its approaches, will be about 1000ft. long. The survey of the line was made by Government engineers in 1909. The railway will put Lima, the capital of Peru, within five days of Iquitos, the head of the rubber industry of the Amazon. The trip from Lima to Iquitos cannot now be made in less than sixty days. It will put New York City within ten to eleven days of Iquitos, as compared with about thirty-five days at present.

NOTES AND MEMORANDA.

One of the difficulties which the Americans have found with regard to the use of four-bladed propellers for aeroplane work is that it is a great deal more difficult to cool the engine than with the two-bladed type.

In overhead telegraph systems, under practical conditions, it is found that about 400 miles is the greatest length of aerial wire that can be operated by means of double current Rey-Morse apparatus. The highest permissible voltage in use is 120.

One half of the cost of an electric vehicle for street cleansing work is represented by the battery, and this is guaranteed to give 100 per cent. of its original efficiency after eight years' constant service, so that, according to Mr. J. A. Priestley, it is quite safe to take the life of one of these vehicles at ten years.

In San Francisco a firm of engineers is designing a ship with a length of 330ft., a beam of 44ft., and a depth of 31ft., with a capacity of 4500 tons, to be built of reinforced concrete. As far back as 1898 a concrete schooner is said to have been employed for some years in the North Atlantic coasting trade.

In an article by Professor A. E. Kennedy, on "The Horse-power Race," in the *Scientific American*, the author gives the average power of a man as 750 watts for a brief interval, say, a fraction of a minute, dwindling to 100 watts or less when maintained for some hours. In order to determine man power, experiments have been carried out at Massachusetts Institute of Technology by athletes running up a flight of stairs, and the results are recorded in the above-mentioned article.

The substitutes which are generally sold under the name of clay soaps or soap substitutes in Germany, are in most cases gelatinous solutions of soda soap in water, with a fatty acid content of 2 to 9 per cent. Excessive prices are charged for these. A white pasty mass consisting merely of magnesium carbonate and water, and without a trace of fatty acid, was sold at 1.2 marks per kilogramme. "Laktarin" soap substitute contains 98.6 per cent. water, and 1.4 per cent. fatty acid, and 0.3 per cent. ammonia, and is sold at 1.6 marks per kilogramme.

The construction of Westminster Bridge is of a singularly composite nature. Up to low-water level it consists only of wooden piles, which have a cast iron shield plate to protect them, and a bed of concrete over them. Then granite piers rise to the springing level. The granite pilasters above form a mere shield again, while the cast iron petticoats, in themselves a useless encumbrance, which do not carry the true line of the bridge, cloak some well-designed metal arches, which had been much better exposed, according to a paper read before the London Society by Mr. W. D. Carõe, F.R.I.B.A.

The United States Bureau of Standards has recently investigated a rather unusual case of corrosion, namely, that of the roofing material of the Library of Congress. The roof of this building has been protected since about 1893 by tinned copper sheets which have become covered within the last ten or fifteen years with small pits. In many cases these pits have extended completely through the sheet. The investigation has shown that the corrosion was due to no accidental inferiority of the material, but that it is to be considered as charactristic of all material of this type. It therefore appears that tinned copper is not superior in any way to tin-plate for roofing material, and that in view of its greater cost can no longer compete with it.

A machine which opens envelopes in a continuous stream is the last word in electrical appliances for the office. According to the *Scientific American*, it is driven by a 1-20th horse-power electric motor. The envelope-opener has opened 73,000 letters in a working day of eight hours. The envelopes to be opened are placed on a feed table in batches of about fifty, and they are fed through one at a time by means of two rubber rollers which pass them along past two cutting edges. The depth of the cut may be varied at will, and there is absolutely no danger of cutting the contents of the envelope, so fine is the cut. A guard eliminates all possibility of the fingers coming in contact with the knives. As the letters are opened they are thrown off to one side of the machine, into a case which is ready to receive them.

The shortage and high prices of platinum, according to *Metallurgical and Chemical Engineering*, has led a firm in Los Angeles, California, to construct crucibles of an alloy of gold and palladium, termed "Palan," which, in some respects, is claimed to be even better than platinum. Thus, according to a recent test by the Bureau of Standards, the loss of weight on severe heating is less, and the resistance to the chief acids greater, than is the case with platinum; on the other hand, it is less suitable for potassium pyrosulphate fusion, and there is also the possibility that its constituent metals may, to some extent, pass into solutions, which would have a small but possibly appreciable effect on a delicate analysis. A curious fact stated by the makers is that this material will not "wet." The meniscus is upward, as in the case of mercury.

The public water supply of Montreal is sterilised by chlorine produced in electrolytic cells from a salt solution. The installation includes a salt storage bin having a capacity of 40 tons of salt, the brine saturating and purifying equipment, two 15 horse-power motor generator sets, four chlorine cells, and silver ejectors and distributing lines for applying the chlorine water to the water to be treated. The brine saturating and purifying equipment consists of three vertical galvanised iron saturators, 27in. in diameter by 6½ft. in height, provided with a spray system at the bottom and an outlet 6in. from the top and two concrete reaction tanks having a capacity of 82 cubic feet each. These tanks are built with sloping bottoms, and have a pipe grid for air agitation. Two sand filters are provided for filtering the purified brine, which passes from the filters to the two concrete storage tanks, having a capacity of 276 cubic feet each. The distributing lines for applying the chlorine water to the water to be treated are 1in. chemical hose. The chlorine gas is ejected into the water by means of a silver ejector, which maintains a 4in. vacuum on the chlorine cells and takes the gas from the chlorine main through the ejector to the distributing lines.

MISCELLANEA.

The fifth installation of 4000 horse-power of the Cauvery Power Scheme at Sivasamudrum Falls will, says *Indian Engineering*, be completed in September next. It will be by far the biggest unit hitherto provided in Mysore. A portion of a generator, quite the last piece of machinery received in these days of restricted freightage, has just been delivered at the works. It weighs 13½ tons, and was taken along from the railhead at Maddur Station inch by inch, on a 12-ton lorry, drawn by 22 pairs of bullocks.

The whole field of agriculture by mechanical aids is certain, for a number of reasons, to be a very active one after the peace, says the editor of the *Commercial Motor*. There will be an increasing tendency to employ small portable power units for the hundred and one power jobs to which the cultivation of the land gives rise. The war will not leave the farmer any the worse off financially. He will, for the first time in his life, have been forced out of his ultra-conservative methods, and with reasonable guarantees of Government continuity of policy, he will be tempted to do more by enlightened means to make the utmost of his land.

The Chinese Ministry of Agriculture and Commerce proposes to encourage the manufacture of Chinese goods and the exportation of raw materials by awarding medals, says the *Ironmonger*. Chinese manufacturers who export annually £10,000 worth of products of any particular class are to be awarded a first-class medal. A second-class medal is to be given to owners and managers of factories having a capital of £5000 or more. Inventors of machines and devices that are found useful in manufacturing industries are to receive third-class medals, and certificates of merit will be awarded to promoters of mining, agricultural, and fishing industries and the founders of Chinese schools.

An interesting announcement has been made to the effect that, under the direction of the Japanese Government Steel Foundry at Yawata, Kiushu, a steel foundry will shortly be established on a site on the Yangtze Valley, not far from the Tayeh iron mine, from which the Government steel foundry is obtaining a supply of iron ore in accordance with the agreement entered into between the Japanese and Chinese authorities several years ago. Already, says *Indian and Eastern Engineering*, a tract of land has been purchased by the Japanese authorities at a point near the Tayeh mine, and the engineering work is now going on there under charge of Dr. Oshima and other experts from Japan.

At a meeting of the Sociedad Española de Construcción Naval, recently held at Madrid, the directors, says the *Iron and Coal Trades Review*, were empowered to proceed with the preliminaries of a scheme for large works to supply the necessary material required by the national arsenals and the shipbuilding industry, such as forgings, castings, and special steels of every kind, and copper, brass, and special bronze. The aim henceforth will be that ships and war material shall be built in Spain entirely of materials produced in the country, for which purpose large works with an annual output worth £1,000,000 are to be established with the technical co-operation of a British group at a cost of about £800,000.

We learn from the *Architect* that Mr. Edwin Seward, a Cardiff architect, after some years of patient study has patented a substitute for mining timber which has been tried and found to give every satisfaction. The chief points about the new props are that they are simple in construction, are indestructible, and do not deteriorate in water or damp. The chief component materials are to be found adjacent to collieries, viz., colliery cinders, stone and crushed clinker, which, when washed, manipulated, combined and duly strengthened, result in a prop the finished weight of which is light enough to allow of efficient handling by one timberman. They are said to be cheaper than timber, and represent in construction the vascular tissues of timber, and are produced in lengths and girths of any reasonable standardised dimensions for special seams or situations. They can be produced ready notched to any angle, rebated or bevelled at the ends according to the requirements of colliery managers.

An important raw product available in the State of Hyderabad which can be manufactured into products of commercial utility is the mowra flower. The mowra tree abounds in the forests and fields of Hyderabad, more especially in the districts of Nizamabad, Medak, and Asafabad. During the hot weather the flowers drop off the tree, and are gathered and dried to the consistency of raisins. Hitherto they have been utilised for liquor only. About 25,000 tons, it is calculated, are gathered annually, of which about 10,000 tons are used for liquor, and the balance is run to waste. It has been discovered that it is possible to make sugar, motor spirit, and several other valuable products out of them. The flower contains, in addition to sugar, acetic acid, and some acetone. It is stated in the *Chemical Trade Journal* that several types of motor cars have been successfully run on a spirit prepared from mowra at half the cost of petrol, and that 100,000 gallons of such spirits can be manufactured from 1500 tons of mowra.

One of the largest and most unusual jib cranes ever built is the 50-ton locomotive jib crane just completed for the Panama Canal dry docks and yards at Balboa, says *Engineering News Record*. It is steam operated and self-contained. The wheel loads range from 50 to 72 tons. The crane has three hoists. The main hoist is capable of lifting, lowering, holding or swinging 50 tons at a maximum working radius of 87ft. from the centre of rotation, in which position of the boom the load can be raised at a speed of 10ft. per min., and to a point 55ft. above the rails. With the boom in the same position the auxiliary hoist, capacity 16½ tons, will have a radius of 97ft., and the whip hoist, capacity 3¼ tons, 102ft. The auxiliary hoist has a speed of 20ft. per min.; the whip hoist has a speed of 40ft. per min. Unloaded hooks travel at double speed and lower themselves on reversing the drums. The jib can be lifted from the ground. The minimum working radius, for the main hoist, is 60ft.; at any radius all hooks can be lowered 56ft. below the rails.

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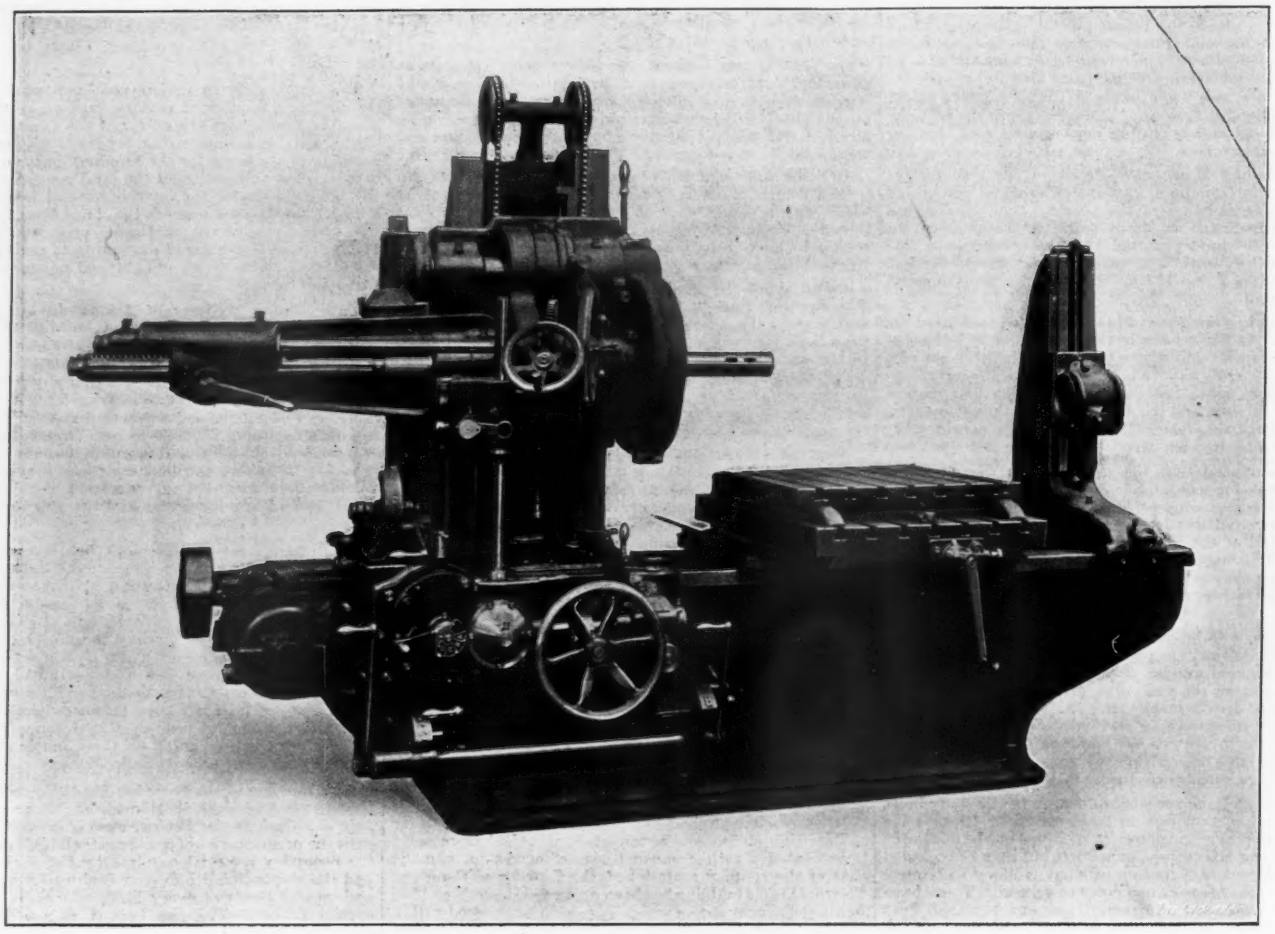

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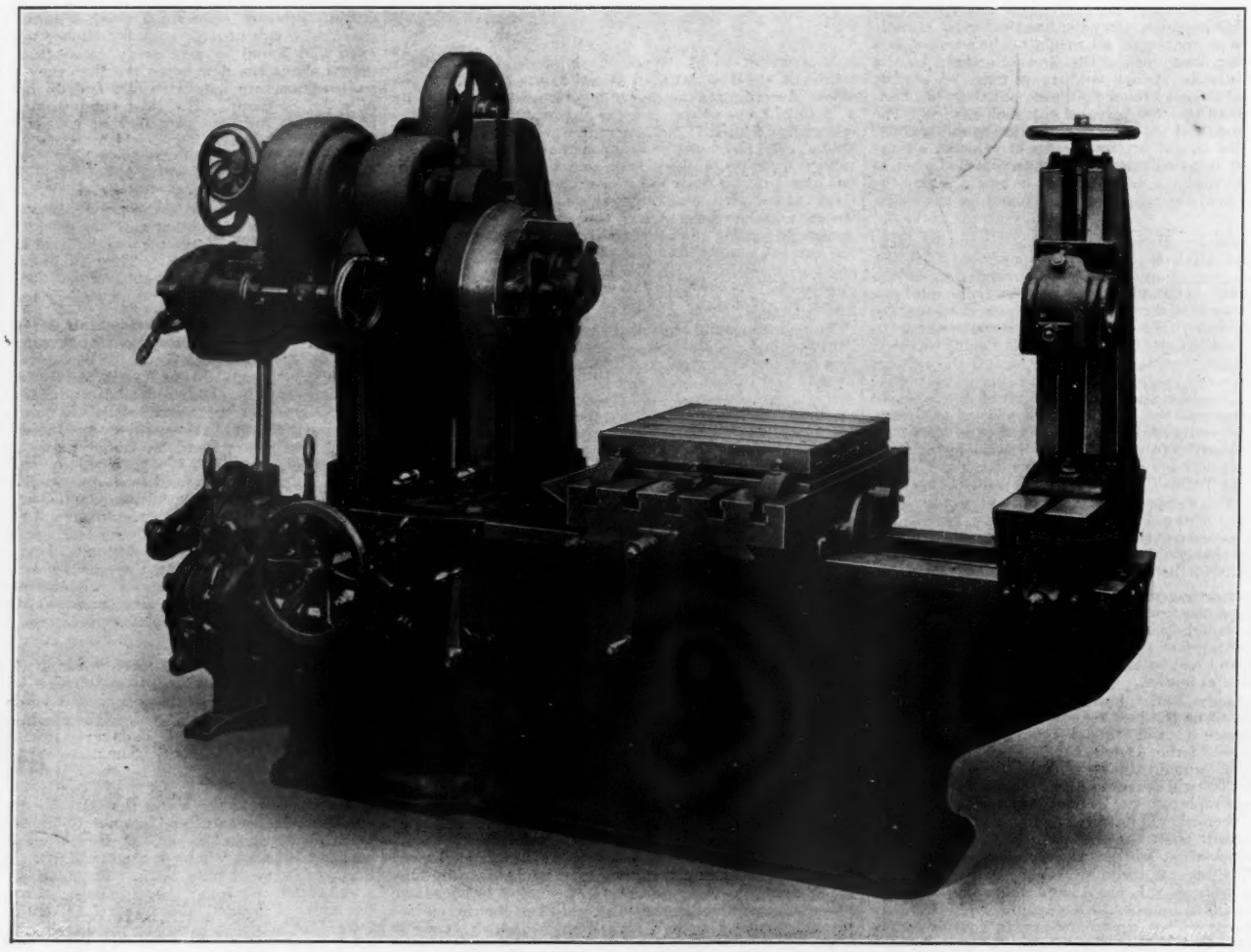

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.

THE LATE MR. ALLISON SMITH.

We are asked by Mrs. Allison Smith if we can help her to trace a photograph of her late husband which, between six and seven years ago, was sent to an advertiser with an application for an appointment. The photograph is the only one in existence, and Mrs. Allison Smith will be very glad indeed to have it back again. We may remind our readers that Mr. Allison Smith was at one time locomotive superintendent of the Victorian Government Railways, and was widely known in Australia and New Zealand. If any reader should find the portrait, and will send it to us, we will forward it to Mrs. Allison Smith.—ED. THE E.

THE ENGINEER.

AUGUST 10, 1917.

Causes of Industrial Unrest.

THE summaries of the seven reports on industrial unrest which appear in to-day's issue cover the whole of the manufacturing areas of England and Scotland, and, as the report of the Commissioners for Wales was dealt with in last week's ENGINEER, the record of the work of the various Commissions of Inquiry is now complete. It will be recalled that the decision to investigate the causes of the widespread unrest arose out of the circumstances connected with the recent engineers' strike. The general suspension of work in establishments, the full activity of which is essential for the effective prosecution of the war, revealed the existence of a spirit of discontent in the workshops which assumed the dimensions of a national peril. In the desire to apportion the blame for this condition of affairs, criticism was indiscriminately bestowed on all concerned. The Ministry of Munitions, the department most concerned, was the chief target of some of the critics; others blamed the workmen, the employers, the trade unions, the Shop Stewards' Committee, and, of course, the Government as a whole; and they were not far wrong, for everybody was more or less at fault. The intense desire on the part of the Ministry of Munitions to "deliver the goods," a task in which it has succeeded beyond all expectation, probably served to blind responsible officials to all questions except the purely material one of output, so that the important individual human elements of which the industrial machine is composed were disregarded. It is an error which will not be repeated; the appointment of the eight Commissions was the first evidence of a real indication to get at close grips with the human problem. It cannot be claimed for the reports that they have added much to our knowledge of the primary causes of industrial unrest, but the work of the Commissioners shows clearly enough how the smouldering spirit of discontent, which burns in the mind of some employers as well as of most of the workers, has been inflamed by the conditions arising out of the war. At the same time it is an advantage to have had our opinions confirmed by these Commissions, and it should be recognised that some of the recommendations made are designed to provide, not merely a palliative for oppressive war-time shop regulation, but to bring about changes in the industrial system of Great Britain which should tend to reduce the old antagonism between Capital and Labour. It will be of interest to view the reports as a whole, and see whither they are leading us.

Those who have been charged with the conduct of these inquiries are not so foolish as to believe that even under the best possible conditions the interests of Capital and Labour can be made identical, or the aims of the State brought into line with individual aspirations. Yet, if the objects sought are not the same, they are clearly not antagonistic, and some of the reports on the causes of the present unrest suggest means by which the lines of policy of the workers and employers may be made less divergent than is now the case. Before any progress can be made in the heroic, but necessary, task of bridging the gulf between Capital and Labour which the sea of discontent has recently tended to widen, the needs of the moment must receive attention. There is general agreement in the reports of the Commissioners that the main cause of the accentuation of unrest to a point where it broke into open revolt against existing conditions is the great increase in the price of food in relation to increases of wages. As is pointed out in the report on the West Midland district, the question of food prices has got into a vicious circle in which every rise in wages is followed by a greater or corresponding rise in prices, until it appears to some minds that the only remedy is to force wages up to such a point that the Government will be compelled to control food prices. The evidence given during the inquiry conducted in the North-Western district indicates that the Government will be expected to deal firmly with every vested interest which stands between the food supply, which the public does not believe to be insufficient, and its distribution to the workers. It is suggested that a new system must be adopted, so that those who are doing the work of the country may be the first mortgagees of the available food supply. The liquor restrictions have generally been loyally accepted as being necessary, although here and there they have been regarded as a hardship. The lack of housing accommodation, which has reached an intense phase in the Barrow-in-Furness area, is a further cause of unrest, and what has happened there as well as elsewhere establishes a case for Government intervention. Apart from these two causes—the food and housing problems, which in themselves are sufficient to account for much that has taken place—another cause is to be found in the new conditions of working brought about by the Munitions of War Acts. These Acts have revolutionised industry, taking away from the workman the right to strike or to change his employment, and withdrawing from the employer the remedy of the lock-out, and practically, owing to the shortage of labour, the right of dismissal. Trade Unionism, with almost all the privileges it had won for its adherents, has, perforce, been suspended; there has been dilution of labour, which must always be unpopular, in controlled workshops, and attempts to introduce it into private work. This in its turn has led to inequality of wages between skilled and semi-skilled, high wages being earned at piece rates by the latter class, while the former, whose work forms the basis for the operations of the partially skilled, are receiving less payment. There is loss in self-respect as well as in pocket. Then there is the vexed question of the promised restoration of pre-war conditions. Many workers, undoubtedly, have at the back of their minds the suspicion that the waiving of trade union rules will be taken advantage of in the post-war period, although the more intelligent party among the men believe that the Government promises were honestly given, and will in the last resort be honestly kept. The opinion is expressed in some, and implied in other reports, that the idea among labour leaders is that these promises will be kept in the spirit rather than the letter. Another cause of unrest which appears to be universal is the delay in the settlement of disputes, and there is justice in this complaint. The employment of women and the attempt by this means to cut wages is another grievance, and the unequal operation of the Military Service Acts is a further apparent injustice which rankles. These are the main causes of the dissatisfaction with present conditions, although other and minor contributory influences are at work. Broadly speaking, there would seem to be a general opinion, not only among workmen and trade union officials, but among employers, that the representatives of the Ministry of Munitions, Shipyard Labour Department, and the Admiralty are not sufficiently conversant with labour problems and labour difficulties.

The plain lesson to be derived from these inquiries is, that unless unrest is to degenerate into industrial anarchy, a remedy must be found. It should be recognised that these labour problems cannot be adequately dealt with by those whose main business is connected with the supply of munitions. In becoming the largest employer of labour the Government has entered on a new field, and there will be agreement with the statement in the report from the North-Eastern area that it is not surprising if the best solution of the inherent difficulties of labour, accentuated as they have been by the abnormal demands of a great war, have not always been found at the first attempt. We believe that the decision should be taken to hand over all labour questions to a special department, and thus get rid of the present multiplicity of control. Some means must be devised of maintaining close touch with the men in the shops and of dealing with troubles and complaints directly they arise. In some of the reports the establishment of shop committees, as to the successful working of which instances were brought before the Commissioners, is recommended. In another report the formation of Joint Standing Industrial Councils is approved. Elsewhere the scheme sketched in the interim report of the Reconstruction Committee finds commendation. There is, therefore, a general con-

sensus of opinion in favour of the principle of District Councils and Works Committees, which should be in the closest relations with a Government department manned by men who possess an intimate knowledge of industrial problems and sound ideas as to the future relations of Capital to Labour, and of both to the State. We may conclude on a note sounded in the report from the North-Western area. What is wanted in industry is a reconstruction of ideas, and both Capital and Labour have got to meet together and carry on the machinery of industry on the principle that they must be ready to reject all prospects of gain which involve loss to others. That this ideal can be reached in the immediate future is, no doubt, something of a dream, but it is an ideal worth striving for, and there are signs that work in which the Government is co-operating is being undertaken towards this end.

The Glasgow Corporation Tramways.

A WEEK or two ago we discussed the accounts of the London County Council's tramways for the year ending March 31st last, and showed that though they were slightly better than they had been for a good many years past, they were far from being satisfactory. A very different state of affairs is displayed in the accounts of the Glasgow Corporation Tramways for almost the same period—*i.e.*, the year ended May 31st last—which have recently been published, and which now lie before us. All that London could show as the result of the year's working, after deducting debt charges, was a surplus of £11,343, to be transferred to the Renewals Fund. Glasgow, on the other hand, after putting aside over £73,000 for the Depreciation and Permanent Way Renewals Funds, was able to pass on a sum of nearly £161,000 to that peculiarly Scotch and most excellent institution, the "Common Good," and this after contributions to various other funds had been made, and taking into account £92,645 paid in war allowances. The magnitude of the difference between these two results is manifest from this broad statement, but it is even greater than the figures alone would seem to indicate. The length of the London tramlines is roughly 150 street miles. The length of the lines worked by the Corporation of Glasgow, including not only those in the city itself, but in the Burghs of Clydebank, Paisley, Rutherglen, and Renfrew, and in the counties of Lanark and Renfrew is nearly 200 miles of single track. As there is but little single track, we may take this as being, say, 100 street miles. London has thus some fifty per cent. more track than has Glasgow. London carried 586,127,976 passengers during the year; Glasgow carried 388,294,876, so that length of track for length of track practically the same number of passengers were carried on the two systems, for if fifty per cent. be added to the Glasgow numbers, a figure of 582,442,314 is arrived at. If anything, London had a slight advantage in this respect. In London the earnings per car mile were just over 12.1d., while in Glasgow they were but 11.59d.

Why, then, does London show up so badly? There are two main reasons. The first is that the original cost per mile of the London tramways, owing largely to the fact that the underground conduit system is extensively employed, was out of all proportion to that of the Glasgow lines—considerably more than double, in fact; and the second that Glasgow tramways are worked more economically than are those in London. The ratio of working expenses to total revenue, including war allowances in each case, were 66.5 per cent. in Glasgow, and 71.2 per cent. in London. By reason of the enormous first cost of its lines, London had to find during the last year a sum of very nearly £750,000 for interest and redemption. The sums paid by Glasgow during its last financial year were £78,846 for interest and £114,378 for sinking fund, or a total of £193,224; and by better management, Glasgow, instead of having to pay out for working expenses, &c., £71 4s. for every hundred it earned, only had to pay out £66 10s. These two factors working together have brought it about that whereas Glasgow's undertaking is not only financially sound, but a great deal more than that, the London tramways are in a well-nigh hopeless condition. Nor has the whole of the story yet been told. The London Renewals Fund on March 31st this year amounted to £282,978 on paper, though its actual value, by reason of depreciation in securities, was considerably less than that figure. In Glasgow, with its much less mileage, the Depreciation and Permanent Way Renewals Funds had to their credit on 31st May, 1916, no less a sum than £2,447,945 9s. 4d. During the year £11,160 8s. 10d. was expended on renewal of track, &c., and £73,304 16s. 6d. was added. In February last the Corporation transferred £2,328,889 15s. 4d. from these funds to the Sinking Fund, and, in doing so, entirely wiped out the whole of its tramway debt. Glasgow, therefore, possesses an extremely well-paying system of tramlines, kept in excellent condition, and does not owe anyone a penny for them; and should the business continue to pay in the same manner as it did during the last financial year, the "Common Good" may look to receive from it each year a sum in the neighbourhood of £350,000. The complete wiping out of its debt by paying back at one stroke a sum representing about 60 per cent. of the total amount spent on the tramways would have been a remarkable feat at any time; but coming as it did after two and a-half years of terrible warfare, it is all the more startling.

The contrast between London and Glasgow is certainly by no means favourable to the former. The Highways Committee of the London County Council complains and has complained for years at the hard conditions under which it has to operate. It bemoans its heavy original outlay; "the abnormal and adverse" conditions under which it has had to work since the beginning of the war, and the money it has to pay on war allowances. It has good reason to bemoan the enormous original outlay; but it is not alone a sufferer by reason of the war. Glasgow has had to face just as "abnormal and adverse conditions," and has had to pay war allowances. Indeed, as far as we can see, she has had to pay, proportionately, more in that direction than has London. We are not in possession of the full details of the London accounts, so cannot tell exactly what had to be paid under this head during 1916–17, but in the estimate for the year's working, it was assumed that the amount would be £122,500. Glasgow paid £92,646. Since London has 50 per cent. more street mileage than Glasgow, its contribution would have been nearly £139,000, if it paid on the same basis as that city. Moreover, Glasgow, in withdrawing that huge sum from its Depreciation and Permanent Way Renewals Funds, has by no means sucked them dry. The balance standing to their credit was still just over £181,000—quite a comfortable figure, when it is remembered that only just over £11,160 had to be spent on track renewal, &c., during the year. There is one other point. It is frequently urged that the Glasgow tramways are so much better off than are those of London, because there are no omnibuses to compete with them. As we have shown, however, the London tramways manage to earn 12.1d. per car mile, as against 11.59d. in Glasgow—the highest figure, be it said in passing, for some fifteen years. As far as earnings per car mile go, therefore, London was not at a great disadvantage as compared with Glasgow during last year, at any rate. There is, however, a striking difference in the figures of the two places. Glasgow ran 25,786,047 car miles and carried 388,294,876 passengers—an average of just over fifteen passengers per car mile. London, on the other hand, ran 49,478,973 car miles and carried 586,127,976 passengers—or an average of 11.9 per car mile. Part of this difference may be due to lack of omnibus competition in the northern city, but not all of it, we venture to think. Some is attributable to better management and less wasteful tram mileage. There are many directions, we submit, in which the London County Council might reap advantage in following more closely Glasgow's example.

INDUSTRIAL UNREST INQUIRY.

THE very comprehensive report of the Welsh Commission of Inquiry into the causes of industrial unrest was dealt with in THE ENGINEER last week. In what follows a summary is given of the results of inquiry in the other seven areas into which the country was divided for the purposes of this investigation. These were London and the South-Eastern area, South-Western area, West Midlands, Yorkshire and East Midlands, North-Eastern England, the North-Western district, and Scotland. The reports vary in value, but viewing them as a whole they form a useful source of reference for information on a subject of national importance, and there will be general agreement that the Commissioners have done their work well. It is impossible in the space at disposal to do more than give thumb-nail sketches of the results of the various inquiries, but the task is simplified by the fact that the causes of the present wave of unrest are stated to be practically the same in all districts, and that the recommendations made are not weakened by any disagreement among the Commissioners as to the measures which ought to be adopted.

In London and the South of England the unrest is said to be real and widespread, and in some directions extreme, and such as to constitute a national danger unless dealt with promptly. We are at the moment, in the opinion of the Commissioners, "within sight of a possible social upheaval, or at least extensive and manifold strikes. No tinkering schemes will meet the requirements of the situation. It is necessary to secure to the working man a fair share of the products of his labour, and a just participation in the establishment of the conditions of industry."

The reports from other districts, if less emphatic as to the character and extent of unrest, are very clear that practically everywhere it is in existence, and, of the need for dealing with the questions at issue drastically and promptly, there is no difference of opinion, although in some areas—notably Scotland—unrest is less acute than at earlier stages of the war. As to the causes there is absolute unanimity that the chief and fundamental reason for the present unrest is the increased cost of food and living as compared with the rise in workers' earnings. In the report from the North-Western district this is stated to be for food, as compared with the period immediately preceding the war, 70 to 75 per cent., whereas the highest figures put before the Commissioners "only showed an increase in earnings of something like 40 to 50 per cent. of pre-war rates."

If, it is stated in the same report, "the Government can solve this question satisfactorily, and can assure to all workers and their women and children a fair portion of the necessaries of life, it would go far to solve the problem of industrial unrest." This view is expressed in somewhat similar language in the reports on other districts. If the food problem were immediately and drastically dealt with, "there might then," in the opinion of the Commissioners for the Yorkshire and East Midlands area, "be restored some measure of faith and confidence in the Government such as unquestionably does not appear to exist either in employers or employed in any of the various industries we have investigated." These are strong words. Closely related to the cost of food, and here the report on Scotland may be quoted, on the question of housing. "Startling evidence has been given," states the Commissioners, "of the acute need of houses in industrial centres." The same point is emphasised in other reports. In Scotland alone there is immediate need for 100,000 workers' houses. In Barrow also the position is very acute; in the London district it is said to be "a problem of great gravity." Where it has not assumed the dimensions of a scandal the subject still presents a real difficulty. The unrest attributable to this cause, it was strongly represented to the Scottish Commissioners, "can only be allayed by the Government taking steps to grapple with a problem which appears to have grown too great for private enterprise now to meet, by in some way having land in the near neighbourhood of congested industrial districts made available on reasonable terms for building working-class houses, and by rendering financial aid for building expeditiously the urgently wanted houses." That there is a widespread belief in the soundness of such policy is made evident in other reports.

Apart from these primary causes of discontent, the war has made it necessary to impose working conditions which have greatly accelerated unrest. The Munitions of War Acts have revolutionised industry. The situation created is admirably outlined in the Yorkshire report. "Apart from the overshadowing question of food and the economic and domestic questions involved, the industrial position has been, and continues to be," states the Commissioners, "seriously affected by causes associated with war legislation, and the numerous and conflicting Departmental regulations following thereon, which, added to some disturbing conditions and irritating experiences that were accumulating before the war in the relationship of employers and employed, have given to a minority of very advanced and visionary workers their desired occasion to inflame practically the whole body of skilled men in the engineering and other trades, in a manner that has already produced strikes and serious retardation of the output of hundreds of thousands of workers in our essential industries."

This broad general statement may be supplemented with detailed examples taken from various reports. The restoration of pre-war conditions is a question which has been the subject of much anxious thought by employers as well as employed. The latter are suspicious that the promises made will not be kept. This, however, is not everywhere the case. "Labour leaders of intelligence," it is stated in the report on the North-Western area, "believe that in the last resort the promises made will be honestly kept, but there is hope they will be kept rather in the spirit than the letter." Then there is the vexed question of dilution. On the North-East Coast the Commissioners find "little real objection to dilution, which has been accepted in principle and largely applied in practice." In the West Midlands we are told "dilution must always be unpopular, but it has been accepted by nearly all trade unions." The men, it is added, are "still suspicious of the women workers," and the Commissioners have been satisfied that "in some instances the employment of women is used to reduce rates." In Scotland "dilution has been a fruitful source of labour unrest, chiefly through the fear that it will continue after the war." The objections raised in connection with dilution have been accentuated by the inequality of wages between skilled and semi-skilled. The London report comments on the fact that workmen of the highest skill are mostly engaged on day work, while semi-skilled workmen and unskilled workmen and women are for the most part engaged on a system of payment by results. Under

this system the earnings of the skilled men are much less as a whole than the earnings of the semi-skilled piece-workers. As this has gone on since the beginning of the war, and as there does not yet appear any satisfactory solution of the topsy-turvey arrangement, the effect on the skilled men has been far from good.

The comments made on the same subject by the West Midland Commissioners put the case quite clearly. "The outbreak of the war found the craftsmen's unions, such as the A.S.E., working mostly on a time rate as against a piece rate. The war caused changes which can be grouped under three heads, (1) the introduction of semi-skilled and unskilled men and women into work previously regarded as skilled men's work; (2) the largely increased output of existing processes giving a greater earning power for the same piece rate; and (3) the introduction of many new processes easily learnt and yielding a high wage at the agreed piece rates. The result has been as great a revolution in industry as any similar period has witnessed. The output has been vastly increased, old processes have been scrapped, and new and more efficient ones introduced. Our industries stand on a different plane from the pre-war period. The effect of increased production, coupled with a fixed piece rate, has been a great increase of the earning power of workers doing repetition work. Wages earned have reached a height hitherto undreamt of. . . . At the same time the toolmaker and the gauge maker, both skilled men whose skill is the basis on which the machine operates, are still working on a pre-war rate, plus the bonuses and advances received since the war, but, taking all these into account, are receiving considerably less than the piece-worker."

Another cause of unrest is the leaving certificate. As it is expressed in the Scottish report, the Munitions Act has, in the workman's view, "deprived him of the right to sell his labour in the market of his own choice," and created a condition, as it is expressed elsewhere, of "industrial servitude." The subject is one which might be reconsidered, as the "feeling now exists," at least among the workers in Scotland, and probably elsewhere, "that whether the leaving certificate was necessary in the early stages of munition manufacture it is not necessary now."

A cause of dissatisfaction which is universal and which is discussed in all the reports, and in some of them at length, is the constant breakdown of the machinery intended for the prompt settlement of differences. The London Commissioners say that "the growth of officialism, the multiplication of departments and the continual changes in *personnel* have resulted in delay and in loss of confidence as to satisfactory dealing with labour problems. There is a distinct opinion amongst both employers and workmen that the Government has intervened to a much greater extent than is desirable, or useful, in the relations between employers and employed, and that it would have been much better had the parties been free to come to agreements and settle their difficulties between themselves.

The North-Western report points out that "employers are even more outspoken in their discontent about matters than the workmen. Promises are given one day, threats are used another, and things that are said to be decided upon and which are already half acted upon are withdrawn and altered without any consultation with leading local employers. . . . The men complain that their grievances do not receive a hearing, or that the hearing is delayed or that it is brought before tribunals and arbitrators who are unsympathetic and untrained in the history and practice of modern industrial conditions." The same complaints come from other quarters—with the exception of the North-East Coast, where it is said "there is general recognition that the officials of the various Government Departments have especially of late shown a readiness to appreciate the difficulties that exist, and an earnest desire to meet them." It is to be regretted that "the general loss of confidence in the Government"—we are again quoting from the London report—"is unfortunately associated with a diminished reliance on the power and prestige of the trade unions." Action by the men themselves has been able to force the Government to do that which they have refused or delayed to do when approached in a constitutional way by the trade union representatives." "The shop stewards' movement" is the subject of reference in these words: "The movement is divided broadly into two sections, one of which seeks to strengthen and sustain the constituted authority of the trade unions, and to improve and ameliorate the condition of the trade unionists by a policy of negotiation; the other consists of more ardent and less responsible spirits, is frankly revolutionary, and does not admit the possibility of improvement in the workers' condition without a radical alteration of the social and industrial systems. The latter section, consisting for the most part of 'Workers' Committees,' is at present in a small minority; but there is a danger that unless some satisfactory arrangement be made for representation of the workpeople in shop negotiations a large section of the shop stewards proper will make common cause with the revolutionary group." It is well that this tendency should have been frankly recognised. The drift towards syndicalism is clearly indicated in several reports, although here again the North-East Coast Commissioners take a far less extreme view than those who have investigated conditions in other districts.

As to the remedies for the unrest which has been revealed, there is almost complete unanimity among the Commissioners. "The Government should," in the judgment of the North-Western district tribunal, "undertake the full control of all necessary foodstuffs. If they fail to do this there will not only be unrest before the winter, but something much worse." The Yorkshire report also calls, in addition to control, for "prompt measures for lowering the retail prices of the essential foods even if the Exchequer has to be appealed to for financial assistance." The liquor trade restrictions have on the whole been loyally accepted, although here and there, as in London, there is said to be "general recognition that the restriction on the sale of beer and the increase in price has produced hardship, ill-feeling, and irritation." The housing problem ought, it is believed, to be taken in hand by the Government.

On the subject of shop conditions, whether relating to dilution, delay in dealing with differences between employer and employed, the high earnings of semi-skilled and unskilled labour, the scheme sketched in the Interim Report of the Reconstruction Committee is generally approved. An excellent summary of recommendations which are in the main concurred in by the Commissioners for other districts is contained in the report from the Yorkshire and East Midlands area. To prevent "the present very serious delay in connection with differences that have been in the past referred to the various Government Departments in London for adjustment or advice, it would appear to be essential to appoint for the period of the war a Commissioner, preferably with technical knowledge, to be resident in the district, with power to hear and settle all questions and disputes on matters concerned with the workers, other than of wages in each district." The report also advocates "the immediate introduction and setting up of workshop committees, composed of equal numbers of workers and of the management, the workers being elected by those employed in each works, for the consideration of questions affecting the industry. Where agreement is not arrived at, or where it may be desired, the Committee may refer any matter to a similarly constituted District Committee, who, in turn, may refer to a like National Committee." The wages question would be dealt with through "the inauguration of a system of an overhead bonus to be distributed among datal workers, and the recommendation to all trade unions where mixed piece-workers and day-workers are employed, that they assist their members by working out some scheme or proposal involving a sharing or pooling of the results secured by piece-workers, so that all day-workers, skilled and unskilled, who are assisting, contributing, or connected with the job, plant or workshop, may participate in the results *pro rata* of their standard day-work earnings." Stress is generally laid on the need, whatever may be the result of negotiations as to labour conditions after the war, "that the Government should at once and emphatically renew their pledge to the unions that at the end of the war the pre-war practices of the workshops shall be fully restored." The unequal operation of the Military Service Acts, which is the subject of special comment in the report on Scotland, is generally regarded as establishing a strong case for reform, inasmuch as "dilutants are stated to be getting the protection against military call which was intended for skilled men." The whole system is said to be regarded by the working classes as "an exhibition of bungling incompetence and of exasperating dilatory methods." It is argued that a new detailed and precise list of protected occupations should be issued, and the unions empowered to distribute cards.

These are the main points of the seven reports, but in conclusion emphasis may be laid on the clear teaching of these inquiries, that much of the existing unrest might have been allayed if there had been more candour on the part of the authorities, which THE ENGINEER has so often advocated, but has in the main preached to deaf ears. A policy of candour "would have removed the prevailing ignorance of the public as to the actual facts, preventing them entertaining wrong notions of all the troubles and so providing a field for propaganda by extremists of all sorts." Much depends on the action which may now be taken.

MINISTRY OF MUNITIONS ORDERS.

BLAST-FURNACE DUST.

THE Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm Regulations, the Munitions of War Acts, 1915 and 1916, and all other powers thereunto enabling him, has ordered as follows under the date of August 7th.

1. No person shall buy, sell, deal in, or dispose of any blast-furnace dust except under and in accordance with the terms of a license issued on behalf of the Minister of Munitions by the Controller of Potash Production.

2. No person shall treat any such dust so as to extract any component part thereof except under and in accordance with the terms of a license issued as aforesaid.

3. All persons producing or in possession of blast-furnace dust shall make returns in regard to rate of production, stocks, purchases, sales, dealings or other matters relating to blast-furnace dust in such form and at such times as may be required by the said Controller.

4. Samples of any blast-furnace dust produced by or in the possession of any person shall be furnished to the said Controller by such person in such form and quantity and at such times as the said Controller may prescribe. Such samples shall be taken in such manner as the said Controller or his authorised representative may prescribe.

5. For the purpose of this Order blast-furnace dust shall mean dust deposited or otherwise derived from the gases of any furnace used for treating ores for the production of iron or any of its alloys.

6. All applications in reference to the above Order should be made to the Controller of Potash Production, Ministry of Munitions, 117, Piccadilly, W. 1.

ROAD STONE QUARRIES.

THE following Order has been made under the date of August 7th by the Minister of Munitions revoking the Orders of the 9th day of May, 1917, and the 14th day of June, 1917, as to road stone quarries.

Whereas by an Order dated the 9th day of May, 1917, the Minister of Munitions ordered that from and after the date thereof until further notice Regulation 9GG, of the Defence of the Realm Regulations, should be applied to all road stone quarries throughout the United Kingdom of Great Britain and Ireland; and whereas by an Order dated the 14th day of June, 1917, the Minister of Munitions ordered that, notwithstanding the said Order of the 9th day of May, 1917, Regulation 9GG should not be applied to any road stone quarry outside England and Wales or to any road stone quarry wherever situated producing only gravel and flint used as road stone and further ordered that the application of Regulation 9GG should be postponed until the 15th day of July, 1917; and whereas the Minister of Munitions is desirous of revoking the said Orders of the 9th day of May, 1917, and the 14th day of June, 1917, with a view to an Order being made by the Army Council in place thereof; now the Minister of Munitions in exercise of the powers conferred upon him by Regulation 9GG and every other power enabling him in that behalf hereby as from the date hereof revokes the said Orders of the 9th day of May, 1917, and the 14th day of June, 1917, and hereby gives notice that the same are so revoked.

BRITISH PRISONERS OF WAR AND THEIR STUDIES.

THOSE of our readers who have been kind enough to help in the way of sending books, &c., for the use of British Prisoners of War, will be pleased to read the evidence of the good work which is being done in the way of enabling our Prisoners of War usefully to employ their time during internment, which is furnished by the following letter, typical of many, which has been received by Mr. A. T. Davies, C.B., of the Board of Education, Chairman of the British Prisoners of War Book Scheme.

"Gefangenen Lager, Doeberitz, Germany.
1st June, 1917.

"I wish to specially thank your Committee for the most excellent work they have done and are doing. In this camp since early 1915 we have had a splendid general library, but we lacked educational books. Your scheme has altogether remedied this defect. I have made many applications to you for all varieties of educational and instructive literature, and there has been no case where the want has not been supplied, immaterial of what branch of trade or study was referred to. I have been wondering if the donors of these books ever have any doubt as to the books reaching the right people, or if their books have been of use. I can only hope no such doubt exists in any single case. . . . In conclusion, may I add that to those who started the Book Scheme, are due the sincere thanks of the large number of British Prisoners of War who have benefited by it, and to yourself for the manner in which its operations are managed.—G. R. MUNDAY, Chief Petty Officer, R.N.D."

Through the instrumentality of the organisers of the Book Scheme arrangements have been made, and in some cases have been in operation for a considerable time, whereby examinations have been held, at a foreign camp, of those students who have been desirous of taking their examinations, notwithstanding their internment. Such examinations have been (or are being) conducted on behalf of the University of Edinburgh, University of London, Board of Trade (Marine Department), Law Society, Royal Society of Arts, London Chamber of Commerce, &c. Increasing use, too, is being made by the prisoners of the "Form of Record," prepared by the Committee of the Book Scheme, which enables the regular studies in any subject of a "Student Captive" to be duly recorded and certified with a view to the record assisting him on his return from captivity at the close of the war.

Contributions in aid of the "Scheme" are, we are informed, urgently needed. In the technical and scientific sections the prisoners' demand for books is very large, but the works asked for are rarely obtainable as gifts, as the owners generally need them for their own use, while second-hand copies, sufficiently up to date, are proving increasingly difficult to procure. In these circumstances, the Committee is compelled to make large purchases of new copies of up-to-date books of the above character, and for this ample funds are essential. Donors to the Scheme will recognise that their gifts do not merely help to save prisoners from mental starvation, but also increase their value as a commercial and professional asset after the war. Offers of books (which should always be accompanied by a detailed list) are also invited, and should be addressed to Mr. A. T. Davies, C.B., "Prisoners of War," Board of Education, Victoria and Albert Museum, South Kensington, S.W. 7.

BOOKS RECEIVED.

Journal of the Royal Agricultural Society of England. Vol. 77. London: John Murray. 1916. Price 10s.

The Journal of the Institute of Metals, No. I., 1917. *Vol. XVII.* Edited by G. Shaw Scott, M.Sc. The Institute of Metals, 36, Victoria-street, London, S.W. 1. 21s. net.

MECHANISM FOR OPERATING RAILWAY SIGNALS

THE McKENZIE HOLLAND, AND WESTINGHOUSE POWER SIGNAL COMPANY, LONDON, ENGINEERS

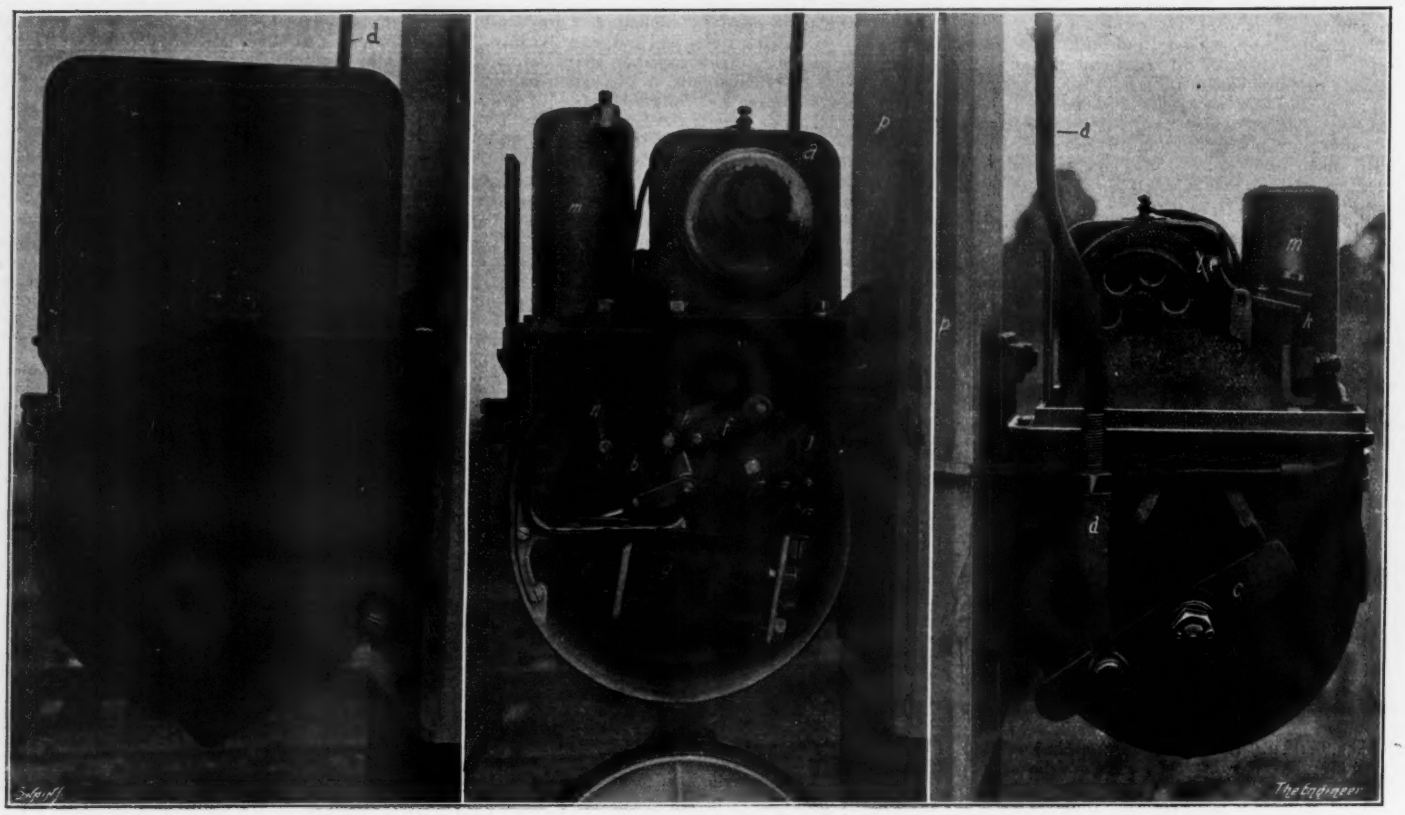


Fig. 1 Fig. 2 Fig. 3

BATTERY-OPERATED RAILWAY SIGNALS.

THERE is one direction in which American railways have an advantage over those in this country. It is there the practice to operate practically all the distant signals connected to signal-boxes by power, whereas British railways almost universally still connect them by wire to the levers in the signal-cabins. One reason for this difference in practice is, of course, the greater extremes in temperature and the more severe climatic conditions. The first of these factors is experienced in the expansion and contraction of the signal wire; where there is frequent and great variation in the temperature it is necessary constantly to regulate the signal wire. As to the other factor—the more severe weather—it is sufficient to remember the great depths of snow that are experienced in the winter months in various parts of the United States. By operating the signals by power neither of these disadvantages are felt.

Were this the more frequent practice in this country there would be more efficient working of signals. The signal arms would come "off" to the accurate angle and would go fully to danger; there would be no necessity for the signalmen to watch their working in order to adjust the wires so as to meet the variations in temperature; the distance the signals were from the signal-box would, so far as their operation was concerned, be immaterial; and therefore the signal could be fixed in such a position as gave the driver the best view and regardless altogether of the distance from the signal-box. This last is, at present, an important factor, as the greater the distance the heavier the signal is to work. With a power-operated signal, the distance out is quite immaterial. There is also the advantage that all counter-balance weights are avoided, and therefore the frequent cause of injury to signalmen when the wires break or the lever slips out of their hand is eliminated. The power operation of signals is, moreover, necessary when they are controlled by two or more boxes. Where such controlling is in existence there is always some trouble in the adjustment of the signal wires; one man is sure to say that it is the other man's wire that is wrong. Where, however, the signals are worked by power there is no question of adjusting the wires nor, as is the case of controlled signals, of the extra weight to be moved. Here, in controlled signals, again is experienced the advantage that distance from the signal-box is immaterial.

In this connection it may be remembered that in his report on the Wigan collision of December 19th last, Colonel Druitt recommended that the distant for No. 1 box should be controlled from No. 2 box, and that it should also be controlled from No. 4 box. We would thus have one wire 983 yards in length, another of 1548 yards and a third of 2138 yards, the want of adjustment in any of which would lead to an irregular signal being shown. From all which recital it will be appreciated that the power operation of distant signals gives better signal indications to the drivers and easier working for the signalmen.

The use of the term "power operated" generally presumes the actuation of the signals from a power-operated locking frame, such as those at the Central Station, Glasgow, or Snow Hill Station, Birmingham; but in what we are about to describe the means employed for actuating the signal is contained in a primary battery and an electric motor. The signal has its customary lever in the signal-box, and from the box to the signal is run an outward wire, similar to a telegraph wire and carried on the telegraph poles. From the signal to the box there is a return wire. In the signal-box is a local battery to which the outward wire is connected, and the opposite pole of the battery is joined to a switch near the lower part of the signal lever in the locking frame. On this lever is a circuit breaker which, when the lever is pulled fully over, joins up the local battery to the outward wire, and current then flows to a relay at the signal and switches in another local battery stationed at the signal. Such a signal is seen in the accompanying illustration Fig. 4. It will be noticed that four wires are taken to insulators near the top of the post, and that there are two battery boxes. Two of the former and one of the latter, also another wire about a third of the distance down the post, are for purposes that are not connected with our present subject. The box containing the local battery connected with the operation of the signal-motor is that at the side of the signal post. Above this battery box, but on the front of the post, is the mechanism case and the signal machine. Of these we give three other views, in Figs. 1, 2 and 3. Fig. 1 shows the front in its normal condition, Fig. 2 the front with the covers removed from the mechanism case and from the motor, and Fig. 3 the back with the cover removed from the motor.

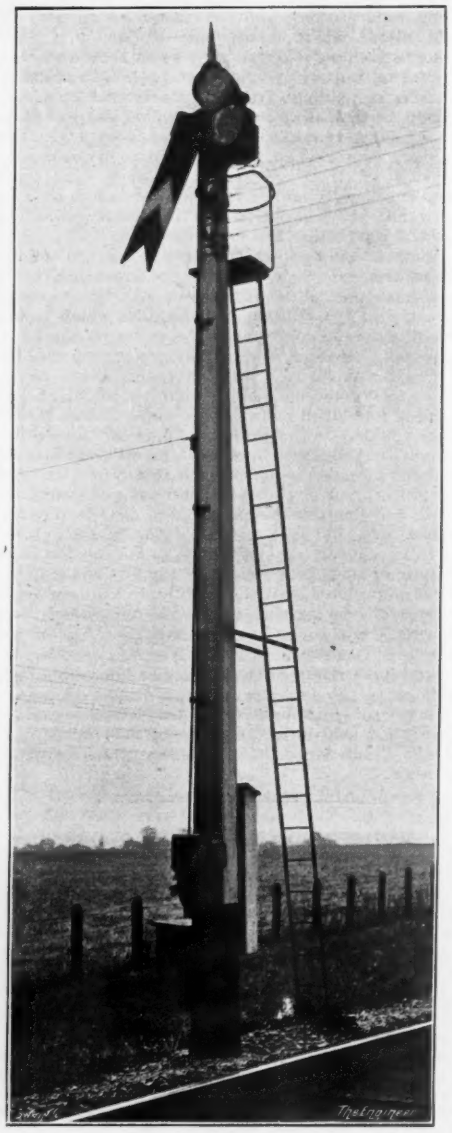


Fig. 4—BATTERY OPERATED SIGNAL

The signal machine consists of a chain of wheels operated by the motor *a*. The wheels always travel in the same direction, and the motor is driven by the primary batteries already referred to. In front of the geared wheel seen inside the mechanism case, is what is known as the slot plate *b*, to which is keyed, outside the case, the crank arm *c*, seen in the back view, coupled to which is the upright rod *d* leading to the signal arm. On the geared wheel are five rollers, one of which, *e*, is seen in the illustration. Any one of these rollers will engage with a pawl co-acting with the pawl *f*. There are two pawls, an inner and an outer, and both are on the same spindle attached to the slot plate. The outer pawl is *f*, and it is the inner, unseen, pawl that is engaged by the rollers. The inner pawl will, however, only be engaged when it is held rigidly; at other times the rollers turn the pawl and pass it. It is held when the slot magnets are energised. When energised, the arrangement of short levers seen above the magnets causes the topmost lever *h* to hold the outer pawl *f* and, therefore, its co-acting, inner pawl.

When the man in the signal-box pulls his distant signal lever from normal to reverse, he joins up the local battery at the signal-box, so that the current is sent over the line wire to a relay at the signal which, when energised, switches in the local battery at the signal and so sends current to the slot magnets *g* and the motor *a*. The effect on the former is that the outer pawl *f*—and therefore the inner pawl also—is held, so that when the motor starts, the nearest of the five rollers on the geared wheel engages with the inner pawl. The pawl, being attached to the slot plate *b*, when carried along with the roller, causes the slot plate to travel through an angle of 60 deg., so that the arm *c* is turned, the rod *d* raised, and the signal arm placed to the "clear" position.

By the time the signal is lowered, the striker *j* on the slot plate has reached such a point that it turns a lever—not seen—in the upper front of the case. This actuates the cut-out switch *k*, thus opening the motor circuit, the motor being stopped by the brake *l*, which is also applied by the lever just mentioned. The circuit to the slot magnets *g* is not, however, interfered with by the actuation of the cut-out switch, and the magnets remain energised so long as the relay is energised by the local battery in the signal-box. As soon, though, as the signalman starts to return the signal lever from reverse to normal, that local battery is disconnected from the line wire, the relay is de-energised—and therefore the slot magnets—so that the

outer pawl *f* is no longer held, and consequently the inner pawl disengages from its roller on the geared wheel and the slot plate is free. As a consequence, the arm goes "on" by its own gravity, the rod *d* falls, the crank arm *c* is turned again to normal, also the slot plate. The return of the arm is graduated by means of a piston in the dashpot *m*. This piston is coupled to the slot plate by the rod *n*.

This particular apparatus was supplied by the McKenzie, Holland and Westinghouse Power Signal Company, Limited, and is fixed on the Great Western Railway. To Mr. A. T. Blackall, the signal engineer of that railway, we are indebted for the photographs used in our illustrations.

WELDING WITH APPLICATION TO AUTOMOBILE ENGINEERING.*

By HERBERT L. TOWNS.

THE evolution of the methods employed by manufacturers in the industrial world is undoubtedly a source of wonder, and probably one of the greatest advances is that of welding. Along with welding has come the cutting of metals by the application of heat, and so great has been the development of these means of manufacture, that the welding and cutting apparatus has become an ideal and absolute necessity to the engineering trade. As far as the automobile section of the engineering trade is concerned, it cannot be said that the process of welding is adopted very extensively in the actual initial production of the necessary parts for the building of automobile vehicles; in fact, the adoption of welding for automobile parts was probably more prevalent in the early days of motor car construction when built-up plate work was used to some extent than in these days of reliable stamping and pressing methods. However, the experimental and also the repairs section of the automobile industry find the welding methods a very valuable asset in the carrying out of the class of work allotted to them. In dealing with this subject it will be advisable to make some classification, and the best method to adopt will be to deal with the process of welding in a general sense, and then consider the possible applications to automobile industry.

Welding is the process of joining two pieces of metal by melting the adjacent edges of the metal together, and the methods of producing the necessary heat has varied, among which are the oxy-hydrogen, the oxy-acetylene, and the electric arc methods. The oxy-hydrogen flame is very rarely, if ever used, as the heat produced by this flame is not nearly so intense as the heat produced by the oxy-acetylene flame, or the electric arc, and as the oxy-acetylene flame is more extensively used, it will be as well to confine all consideration to this method. Oxy-acetylene welding is classed as an autogenous welding process, in which two parts of the same metal, or different metals, are joined by melting of the adjacent edges of the two parts, and causing them to become joined without the use of hammers or any form of compression being used, the melting of the edges of the pieces of metal being performed by the heat produced by an oxy-acetylene flame. It may be well to mention that the term "autogenous welding" is often used as being the method of welding performed by the heat of the flame produced by the combustion of a mixture of gases; but the correct meaning of "autogenous welding" is the joining of pieces of metal and uniting without the aid of any foreign material. The oxy-acetylene flame is very small in size, and is made by the combustion of a mixture of oxygen and acetylene, which mixture has been made in a special burning torch or blow-pipe.

ACETYLENE.

Acetylene is a gas, which is quickly and readily produced from raw material—calcium carbide—by the interaction with water, and is, if we may use the term, a very efficient gas, which fact can be gathered from a comparison with other gases; for instance, the raw material required for the production of acetylene is, relatively to the gaseous product, less bulky than the raw material required for the production of other gases; again, when compared with coal gas, acetylene, on combustion, yields about three and a-half times the heat yielded by the combustion of coal gas.

The raw material required for the production of acetylene—calcium carbide—is a crystalline substance which is artificially prepared by the melting of lime and coke together in an electric furnace, under a heat in excess of 6000 deg. Fah., this crystalline substance being a chemical compound of metal calcium with carbon, one part (or atomic weight) of the calcium being united with two parts (or atomic weights) of the carbon, the composition being expressed in symbols is $Ca C_2$. The great heat employed is necessary owing to the extreme difficulty to melt both calcium and coke, these two substances being among the most difficult to melt that are known. Calcium carbide has very few known uses beyond being the agent for the production of acetylene, and when not being used for this purpose it must be kept dry, which is accomplished by storage in airtight tins or steel drums.

Acetylene may be quoted approximately, in what are probably more familiar terms, as 92½ per cent. of carbon, and the balance hydrogen, this only being approximate on account of certain small percentages of impurities that may exist. The presence of hydrogen retards the combustion of carbon in oxygen, so in order to get a more rapid combustion, oxygen is mixed with acetylene, which mixture generates the hottest flame for welding, a heat of up to about 7000 deg. Fah. being obtainable. This heat is greatly in excess of the heat produced by the oxy-hydrogen flame, the heat generated by the oxy-hydrogen flame being only about 4000 deg. Fah.

ACETYLENE GENERATORS.

There are various types and makes of generators now on the market. A type of generator suitable for attaching to a portable welding plant is shown in Fig. 1. This generator is very compact, light in weight, and has the advantage of being adaptable to almost any portable framework, as it requires no fixing. Adjustable chains can be fitted to the side of the tank for the purpose of carrying the oxygen cylinder, in which case it is unnecessary for the generator to be fitted on a framework, but can stand on the floor, and be moved from place to place as required. The following table shows the size of the generator in comparison with the output of acetylene.

TABLE I.

Height.	Weight.	Output of acetylene. per hour.	Charge of carbide.
Ft. in.	Cwt. qr. lb.	Feet.	Lb.
4 9½	3 2 0	50	20
6 6	4 1 14	70	30
7 3	4 3 0	100	50
7 9	6 2 0	150	75

A generator of this description is automatically controlled, and therefore requires little or no attention, save the charging of the carbide tray, and the filling of the water tank. It will be seen from Fig. 1 that the carbide

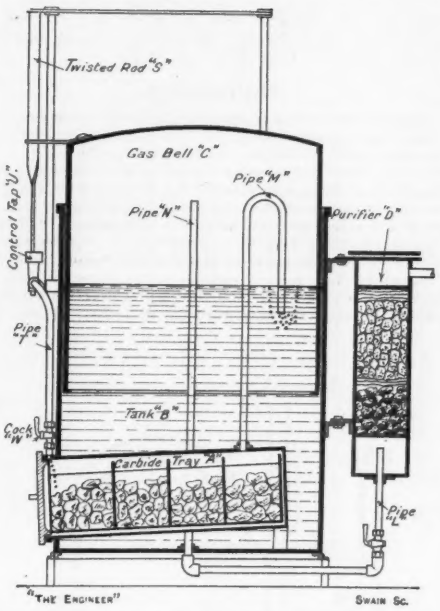


FIG. 1—GENERATOR FOR PORTABLE WELDING PLANT

chambers are actually contained in the water tank which makes the generator very compact. The plant is worked as follows:—Carbide is placed in the generators A—the sketch only shows one, but two are fitted side by side—and the tank B is filled with water. The cock W, which is fitted to the pipe T, connecting the water tank with the generators, is then opened, and water flows from the water tank to the generator; acetylene is then produced and passed through the pipe M into the water, through which it bubbles into the gas bell C; as the gas bell fills with acetylene it rises, being steadied by guide and pillars. One of the guides on the gas bell has an extension fitted, which engages with a twisted vertical bar S, this bar controlling the water cock U. Now, as the gas bell fills and rises, the bar S is automatically operated to shut off the water cock U, this preventing further flow of water from the tank into the generator. The acetylene is taken from the gas bell through the pipe N, and is passed through the purifier D to the burner. It should be noted that the acetylene is first purified by being passed through the water, from the pipe M into the gas bell. As the acetylene is used, the gas bell falls, and the cock U is again opened to allow water to pass into the generator, and the process repeats itself.

A type of fixed generator is shown in Fig. 2, which type of plant does not differ in principle from that shown in Fig. 1. In this type of plant, the generators and the purifying chambers are independent of the gasholder. It will be noticed that a special washing chamber H, is provided, through which the acetylene is passed from the generators to the gasholder.

The following table shows a comparison of the size and output of these types of plant.

TABLE II.

Height.	Weight.	Output of acetylene per hour.	Charge of carbide.
Ft. in.	Cwt. qr. lb.	Feet.	Lb.
6 8	13 2 0	100	36
6 8	16 3 0	140	50
6 8	19 0 0	160	60
9 3	22 2 0	175	75
9 3	27 0 0	250	100

In each of these types of plant the generators can be re-charged with carbide, without in any way disturbing the supply of acetylene, as the gas cannot get back from the holder into the generators. These types of generating plants are manufactured as standard articles in various sizes by the Imperial Light Company.

The gasholder or bell used in acetylene generating plants answer the double purpose of storing the gas, and also being the means of giving the necessary pressure for driving the gas through the pipes, &c., to the blow-pipe. If W be taken to represent the weight of the bell, in pounds, and A to represent the area of the surface of the water, in square inches, then W/A will equal the pressure of the gas in pounds per square inch. There are inaccuracies in this formula, due to the lifting power of the gas, which is lighter than air, and also the effective weight of bell is reduced by part of it being immersed in the water; however, these inaccuracies are, as a rule, negligible.

In the construction of acetylene generators the use of copper piping is prohibited on account of the peculiar results obtained. When acetylene and copper come in contact with each other, under certain conditions, a compound is produced which is of a highly explosive nature when dry; consequently, the use of copper piping would prove to be a dangerous practice. Brass is also a dangerous metal to use in the construction of generators, as in brass there is the presence of copper in percentages varying according to the quality of metal, which again causes the formation of explosive compounds.

A method of supplying acetylene to the welding torch, which is not commonly used in practice, is that of having the gas stored in tanks or cylinders, instead of generating it. The acetylene contained in these tanks or cylinders is dissolved in a liquid called acetone, this being the only known liquid that will dissolve acetylene to any appreciable extent. Acetone will dissolve twenty-four times its own bulk of acetylene at ordinary atmospheric pressure, and also possesses the strange feature of destroying the highly explosive nature of acetylene, while they are mixed together. This feature has the extreme advantage of rendering cylinders of dissolved acetylene safe for handling and transporting, an advantage which is worth consideration. Acetylene is probably more useful in this form for purposes other than welding; for instance, the lighting of automobiles and ships, where generators would be a more dangerous fitment; also there is the possibility of drawing the acetone out of the cylinder with the gas; if the rate of discharge of the gas becomes excessive, the result of this would be a reduction in heat of the flame.

OXYGEN.

The oxygen which is used to support the rapid combustion of the acetylene is not, as a rule, manufactured by the consumer, and there is actually only one firm in this country at present which manufactures this gas in any appreciable quantities. The supply of oxygen is by no means adequate to meet the demand for industrial purposes, and some idea of the demand can be gathered from the fact that the British Oxygen Company alone, which is at present making additions to its oxygen-producing plant, hopes, when this is completed, to have an output of, approximately, 375,000,000 cubic feet per annum, or about 1¼ million cubic feet daily.

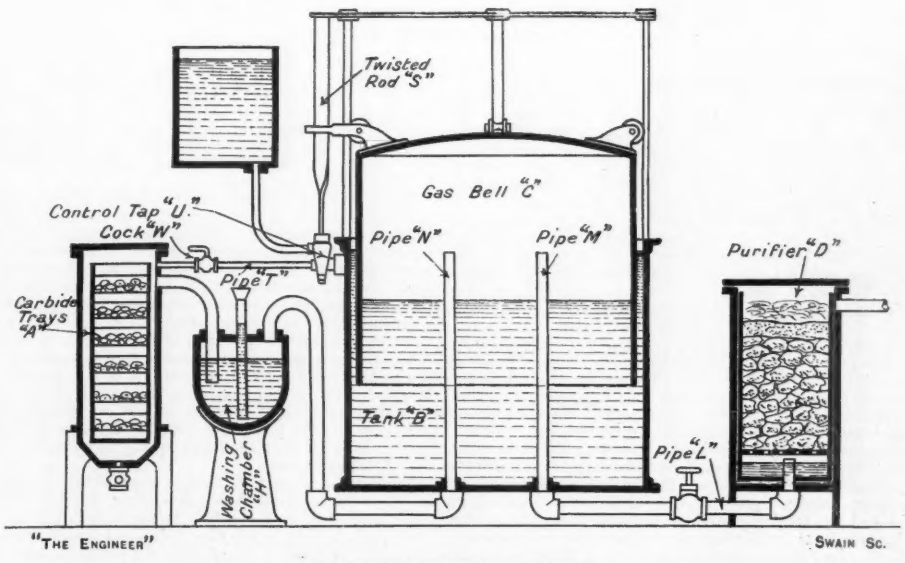


FIG. 2—FIXED TYPE OF GENERATOR

Various methods are employed now for the production of oxygen, but the most common method is by the electrolysis of water. Oxygen is passed after production into storage tanks where it is compressed to, approximately, 1800 lb. per square inch, and is then passed into steel portable cylinders, under this pressure, ready for use. It may seem superfluous to mention that oxygen cylinders require most careful handling, but cases of accidents are frequently being reported through these cylinders being carelessly handled. Oxygen cylinders filled with the gas

* Paper read before the Coventry branch of the Institution of Automobile Engineers. Abridged

should be stored in an outhouse, where the risk of fire is an absolute minimum, on account of the variation in pressure due to the variation in temperature; for instance, in the case of a 100 cubic feet oxygen cylinder, the pressure of the gas varies from about 1560 lb. per square inch to about 2300 lb. per square inch, as the temperature varies from 0 deg. Fah. to 212 deg. Fah. It will be seen from this that care should be taken as to the position chosen in a shop for placing these cylinders.

Oxygen cylinders are fitted with regulators for controlling the working pressure of the gas, and coupled with these regulators are indicators for recording the contents of the cylinders. It is a dangerous practice to introduce grease or oil into a cylinder valve, as oxygen has an oxidising action on oils and grease, and the rush of the gas through the valve will raise the temperature of these materials to such an extent that spontaneous combustion will take place on the gas reaching the regulator.

The pressure and consumption of oxygen is governed by the size of blow-pipe used to suit various thicknesses of metals, as will be seen from Table III.

TABLE III.

Thickness of metals to be welded. Inch.	Approximate oxygen pressure required. Lb.	Approximate consumption per hour. Oxygen. Cu. ft.	Acetylene. Cu. ft.
1/32 to 1/16	5	2	1¼
1/16 to 1/8	6 to 7	3½	3
1/8 to 1/4	7 to 8	8	6
1/4 to 3/8	13 to 14	14	11
3/8 to 1/2	21 to 22	35	28
1/2 to 3/4	27	55	42
3/4 to 1	30	78	63
1¼ to 1½	37	100	80
1½ to 2	40	125	100

Oxygen cylinders are made in sizes varying to contain from 10 to 200 cubic feet of the gas, the size most commonly used being the 100 cubic feet. The actual capacity of this cylinder can easily be calculated; for instance, as has already been mentioned, the oxygen is compressed to, approximately, 1800 lb. per square inch, which is equivalent to 1800÷15 (pressure of the atmosphere)=120 atmospheres. Now, according to the "law of gases," which is, perhaps, more commonly known in this country as "Boyles law," the volume of a gas varies inversely as the pressure of the same mass of the same gas, providing the temperature remains constant; therefore, as the pressure of the oxygen in the cylinders is 120 times the pressure of air, the volume of the cylinder is only 1÷120 of the actual volume of the oxygen at atmospheric pressure, which gives us the following result for a 100 cubic feet cylinder:—100÷120=.833 cubic feet. This actual capacity of the cylinder can be measured by pouring water into it, which would require just over five gallons of water.

This knowledge of the oxygen cylinder may seem to be of little practical value, but if the welder knows the actual or water capacity of the cylinder, he can determine the approximate volume of gas remaining in a cylinder. This information is very useful and, in reality, essential, in the case where a welder has a partly spent oxygen cylinder, and a somewhat lengthy piece of welding to do, in order that it may be ascertained if sufficient oxygen is available to complete the work. As an example, the following may be taken:—Say a piece of welding work is required on metal of ⅜in. to ¾in. thick, for a length of, say, 2ft. This will necessitate the use of a blow-pipe, which will consume 42 cubic feet of acetylene per hour, and the work would require about half-an-hour in which to be completed, as will be seen from Tables III. and IV. (*post*). The consumption of oxygen for this work would be approximately 27½ cubic feet. Now, if we assume that the welder has one 100 cubic feet cylinder, which is indicating a pressure of thirty-six atmospheres, would it be possible to execute the work? The welder, knowing the actual or water capacity of his 100 cubic feet cylinder, say, .833 cubic feet, can easily estimate the possibilities of being able to complete the work with the use of this cylinder. Knowing the pressure of gas in the cylinder (thirty-six atmospheres), and the capacity of the cylinder (.833 cubic feet), the volume of gas at his disposal is equal to 36 × .833 = 30 cubic feet (approximately). If we deduct, say, two or three cubic feet which remain in the cylinder when the pressure has fallen to about two atmospheres, and allow for the possibility of a slightly larger consumption of oxygen by the blow-pipe, we are left with, approximately, twenty-six or twenty-seven cubic feet of oxygen, and it would probably be possible to finish the work if it were done rapidly.

The use of oxygen, produced by the electrolysis of water and supplied in cylinders, is found to be the most economic, providing the facilities for the transportation of the cylinders are sufficiently adequate. In industrial centres this condition is existent, but in places which are at a distance from any industrial centre, the transportation of goods of any description may be a problem, in which case the use of oxygen prepared in the vicinity of the consumer would probably be more economical.

This can easily be done by using a specially prepared substance known as oxygenite. Oxygenite is a yellow substance, having a sandy appearance, and is produced by methods which have, as a basis, the production of oxygen by the auto-combustion of potassium perchlorate. The production of oxygen from oxygenite is performed by combustion in a special apparatus, 1 lb. of oxygenite giving about four cubic feet of oxygen.

INSTALLATION.

Having considered the production of the necessary gases for oxy-acetylene welding, the next point for consideration is the carrying of the gases to the place for burning.

Where a fixed generator is used it is necessary to have fixed pipes for the service of the acetylene to the place—or places where more than one blow-pipe is being served—of welding, and the gas fed to the blow-pipe by a flexible tube connection from the service pipe. Just as the use of copper is prohibited in the manufacture of acetylene generators, the use of copper tubes is prohibited for serving the gas to the blow-pipe; therefore iron pipes should be used for this purpose, and these should preferably be galvanised, as the presence of any moisture in the gas would tend to form iron-oxide, which may leave the pipe and accumulate in some more vital part of the installation. These fixed pipes should be fitted to the wall of the shop, and should be arranged with a slight upward run, so that any moisture forming in the pipe would tend to run back to the generator.

The size of the pipes fitted depends entirely on the number and size of the blow-pipes to be used, and this should receive careful consideration in arranging for the fitment of an oxy-acetylene welding installation in any establishment. There is a danger of the pipes being too small in size, which results in the acetylene arriving at the blow-pipe in insufficient quantities, and probably at a considerably reduced pressure; hence, the welder may have to increase the pressure of the oxygen he is using, with more or less disastrous results, as will be seen later in the consideration of the proportions of the gas mixture. It should be remembered that the length of the piping should be taken into account, as well as the size of the blow-pipes to be used, when fixing the diameter of the piping, in order that the loss of pressure of the acetylene may not be excessive.

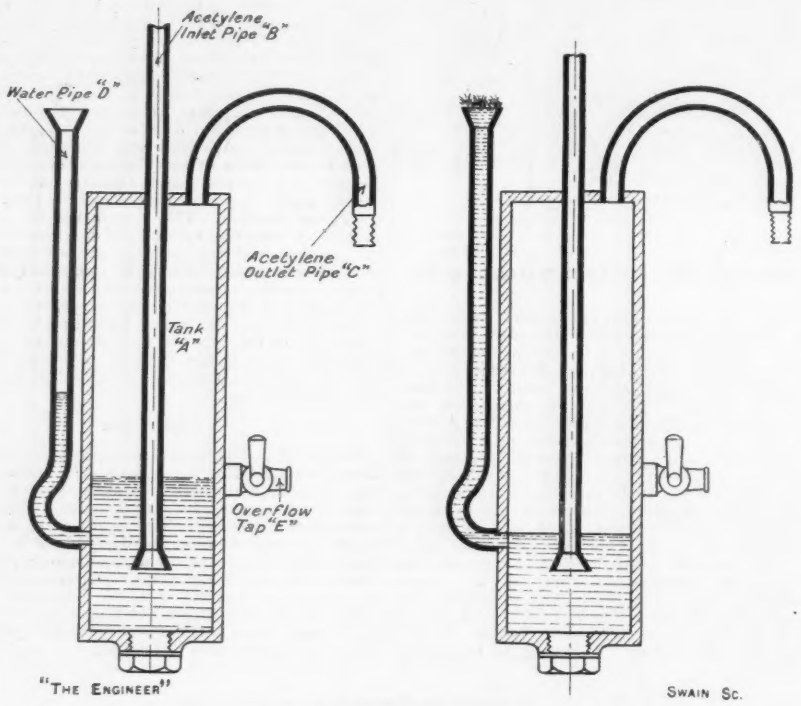
There is an apparatus that is absolutely indispensable in the welding installation, this being the safety valve. As a matter of fact, a safety valve is required for each blow-pipe, which, in the case where a portable acetylene generator is used, is fitted to the generator, and where a fixed generator is used, they are fitted to the fixed service pipes, in each case the acetylene passing through the valve, which is also connected to the blow-pipe by flexible tubing. A type of safety valve is shown in Fig. 3, a description of which is as follows:—The apparatus consists of a chamber or tank A, which is fitted with a filling pipe D, oy which the tank is partly filled with water, the level of the water being regulated by the drain cock E. The pipe B is connected to the acetylene service pipe, and an outlet pipe C, to which the flexible tube is connected, is provided.

The object of fitting this safety valve is to prevent any oxygen from getting into the acetylene pipes, which is what would happen in the case of the blow-pipe becoming temporarily choked up due to the splashing of molten metal or other causes, if a device of this description were not fitted, as the oxygen is always being fed at a greater pressure than the acetylene; hence, this safety valve prevents the forming of a mixture of the two gases in the pipes, which would be of an explosible nature and consequently dangerous in case of the flame back-firing.

The acetylene is passed from the service pipe into the water, through which it bubbles, and passes through the outlet pipe to the blow-pipe. In case of a stoppage in the blow-pipe the oxygen passes through the flexible tube into the tank A, and as the pressure in the tank is increased, due to the oxygen not being able to gain an outlet, the water level in the tank becomes lower by the water passing into the falling pipe and the acetylene pipe, until the level of the opening into the filling pipe is reached, then the oxygen bubbles up through the water in the filling pipe and escapes into the air, as shown in Fig. 4. These valves require very little attention, save the checking of the water level by the drain cock when the system is in use, this being preferable to get the correct level under working pressure.

The feeding of the oxygen to the blow-pipe is done through flexible tubing of three-ply rubber, which is preferable to metallic flexible tubing, owing to the increased danger arising from the deterioration of metallic tubing not being so noticeable as of the rubber tubing.

(To be continued.)



Figs. 3 and 4—SAFETY VALVE

COAL CONCRETED FROM DUSTS OR ASHES.*

By R. GOULBURN LOVELL, A.R.I.B.A., M.S.A.

THE Coal Controller, in describing the basis of his scheme for coal transport, has said that the first main principle is: "The consumption of coal should take place as near the producing point as possible." If a fuel can be concreted from any waste of calorific value in the localities where they exist, it is clear that we shall be assisting the country by the reduction of coal transport, and by the utilisation of waste. The transport thus saved would be available for our Allies, and the waste thus utilised would be to the advantage of ourselves. We hope to prove that this is possible. I am permitted by the President of the Society of Architects to comply with the suggestions made at the last meeting: That the process of manufacture should be demonstrated, and that the analysis of the component parts and the resultant fuel should be shown.

My colleague, Mr. C. M. Hughes, and I are anxious to explain all that we can, and to submit the results of our work to the same criticism as before. We do not claim that our process increases the total thermal value of the aggregates, but we do say that there are many so-called waste materials which may be converted by this simple process into a fuel valuable for many purposes. By its means a British thermal unit costs less than that obtained by means of Nature's coal. This is the point that must appeal most strongly to the commercial mind.

As explained last month, there are three methods of making the fuel, which may be called A, B, and C. These three methods will be demonstrated, simple domestic utensils being employed. It will thus be possible for manufacturers to judge the class of plant which exists all over the country, and which can be used for immediately putting into operation the manufacture of this fuel for use during the winter months. A and B may be termed dry processes. In this case we take as aggregates ashes and coal dust. The familiar cinder-sifter first plays its part by sifting the fine dust which is of little or no value. The coarse aggregate is therefore composed of all between ¼ and ¼ mesh. This is dried, if you like, in the domestic frying pan; it is then sprinkled with a special sugar-waste solution and again dried. The fine aggregate is taken from the coal cellar dust, only that which passes ¼in. mesh being used. These two bases should be intimately mixed with the matrix or binder. For this purpose I employ an old butter churn, cake mixer, or other suitable utensil, failing which the whole mixture can be well shaken or mixed together by hand. Up to this point A process and B process are exactly the same. Process A is employed wherever the sun has much value, or where heating chambers are available. The mixed aggregates and binder have in some cases a small quantity of creosote oil added, placed into moulds, and allowed to concrete, the time, of course, varying with the amount of heat available. The fuel, when cold, is emptied out of the moulds, broken up, and is hardened by exposure to the atmosphere.

With Process B, the small quantity of creosote oil, if used, is placed in a boiler or an iron saucepan, the mixture of bases and matrix is added and placed upon a fire and stirred until a temperature of about 120 deg. Fah. is obtained, when the whole is emptied into any mould, such as an old pail or bath. In a short time it is cold, and is emptied out, broken up, and allowed to harden.

Process C is a wet process in which there is no need to dry the aggregates. They are mixed as before, but with a different matrix mixture; the creosote oil, if used, is added and well mixed, the whole is then moistened with the solution until a consistency of mortar or concrete is obtained. It is then emptied into shallow moulds, or between sheathing boards, and dried by exposure, but with protection from the wet.

In all three processes the character of the matrices varies with the character of the aggregates, and the different aggregates have to be treated in different methods. It is usually found that in most cases the smoke of the resultant fuel can be diminished by an increase of the remaining ashes; in the case of furnace fuels the clinkering can by this means be diminished. As will have been observed, this method of concreting fuel dispenses with any kind of pressure beyond a slight tamping into the moulds. Capable men are required to control the manufacture in order to standardise, as far as possible, the qualities of the various fuels.

Process A is more particularly suited to those climates favoured with a succession of sunshine, or it is equally well suited to those industrial concerns having ovens or heating

* Read before the Society of Architects, July 26th, 1917. See also THE ENGINEER, June 15th and June 22nd, 1917.

chambers where the moulds and their contents could remain for twenty minutes or half an hour. For low-grade cokes, coals, or bar ashes Process A is the best method.

Process B is suited for any form of rotary asphalt plant, either fixed or movable. I understand that many road construction firms have plenty of these portable heaters, which are possibly unemployed owing to the war. These could be taken to any dumps of coal slack, coke dust, or cinders, and very quickly transform them into a good fuel. Even after the war it is conceivable that these portable machines could be better employed in this manner than on road making. Our researches have proved that certain blendings of calcareous and carbonaceous matters go to form a hard road mastic which may be termed malleable. Road engineers will understand the full significance of this, and I shall probably have more to say on this subject later on. For all materials high in carbon but low in volatile matter, Process B is the best method.

Process C is the cottager's process of producing coal in his own backyard. Of course it would be better for a community to send its ashes and dusts to a central depôt, and there have it done under proper supervision; but there is nothing to prevent an isolated individual or firm from utilising its waste materials by this process. The ordinary form of concrete mixer could be taken to any dumps of waste material in the same way as the ordinary asphalt mixer can be employed as before described. For high-grade cokes, high-grade bituminous coals, or a mixture of the latter with ashes, peat, sawdust, &c., Process C is the best method.

Having demonstrated by simple appliances the different processes of manufacture, I have now to submit a tabulated statement of the analyses of seven different types of fuel made under the three processes, together with the calorific values of their component parts. The services of the West Ham Testing Laboratory have been employed in this connection, and the thermal values have all been determined by the Mahler-bomb calorimeter. The tabulated statement is as follows:—

Tabulated Analyses.

Name.	No.	Volatile Matter.	Coke.	Ash.	Fixed carbon.	B.T.U.'s of Bases.	B.T.U.'s of component parts.	Percentage of raw material as finished fuel.	B.T.U.'s of resultant fuel.
Anthracite dust	64 An. B.	13.26	84.92	12.16	72.76	—	12.775	91.38	12.570
" " Bases	"	5.78	91.77	6.42	85.35	13.660	—	—	—
" "	73 An. C.	13.57	84.38	21.52	62.86	—	12.027	99.02	11.870
" " Bases	"	5.45	91.63	6.20	85.43	13.690	—	—	—
Anthracite and peat	68 An. P.B.	23.82	74.04	20.76	53.28	—	8.272	92.80	8.150
" " Bases	"	17.34	76.57	15.22	61.35	7.650	—	—	—
" "	69 An. P.C.	22. 7	75.39	22.98	52.41	—	8.280	96.55	8.170
" " Bases	"	17.41	76.71	15.31	61.40	7.830	—	—	—
Ashes and peat	66 A.P.B.	21.16	77.10	51.42	25.68	—	6.786	98.22	6.690
" " Bases	"	12.41	85.32	56.18	29.14	5.340	—	—	—
" "	74 A.P.C.	30.23	67.20	42.38	24.82	—	6.520	98.25	6.435
" " Bases	"	16.29	81.21	48.78	32.43	6.360	—	—	—
Ashes and coal dust	62 Al.B.	15.44	83.95	27.57	56.38	—	9.041	98.05	8.910
" " Bases	"	5.17	92.78	35.96	56.82	8.890	—	—	—
" "	72 C.Al.	16.86	82.13	38.64	43.49	—	8.094	97.14	7.980
" " Bases	"	5.15	92.75	56.20	56.55	8.870	—	—	—
Kent coal dust	59 S.B.	29.32	69.54	21.30	48.24	—	11.422	98.35	11.250
" " Bases	"	25.22	73.41	20.20	53.21	11.870	—	—	—
" "	58 S.C.	30.83	67.53	24.86	42.67	—	10.375	99.58	10.230
" " Bases	"	25.22	73.41	20.20	53.21	11.870	—	—	—
Kent coal dust and washings	60 S.B.	18.26	80.96	59.14	21.82	—	5.669	98.62	5.580
" " Bases	"	11.52	87.64	65.68	21.96	4.440	—	—	—
" "	61 S.C.	19.98	79.15	57.72	21.53	—	4.400	93.33	4.980
" " Bases	"	11.62	87.49	64.90	22.59	4.460	—	—	—
London coke	57 L.B.	21.40	77.69	23.96	53.73	—	11.261	96.10	11.110
" " Bases	"	8.20	89.95	17.94	72.01	11.620	—	—	—
" "	71 L.C.	15.43	83.10	30.29	52.81	—	10.107	98.86	9.980
" " Bases	"	8.12	89.99	17.88	72.11	11.640	—	—	—

It will be observed that these examples extend from peat to anthracite. Samples of materials from which they have been produced, and the samples of the resultant fuel, are shown in each case; they will light from the sticks, incandesce, and flare. This is perhaps more remarkable in the case of anthracite dust. There are many collieries where fine coals are produced to-day in abnormal quantities, due to unusual friability, as, for instance, the Kent coal shown in the tabulated statement. I understand the percentage of slack is over 70 per cent. of the total output. It is here demonstrated that by our process fuel can be economically made equal in value to the large coal worked in the same seams. By utilising this mine to its full extent, the Coal Controller's problem of transport in Kent and Sussex would be very much diminished.

We are only now awakening to the enormous waste that has been taking place in this country in the consumption of coal, the valuable chemical by-products of which have been lost beyond recovery. Mr. Madden, the Gas Engineer of Cardiff, has stated in an address: "The system we employ to burn this valuable gift of Nature will be accounted to us as a barbarism by future generations when the coal supply of the world is running low in the cellars of the earth."

The conservation of our wonderful coalfields is a duty imposed upon us. Our industrial supremacy in the past had been founded greatly upon our riches in this respect; therefore in the present time of stress it behoves us to adopt every effort to extract every benefit we can from every coal mine in the country. Professor Franke, in his recent book, has stated that the production in one year in Great Britain was 250 million tons of bituminous coal; the waste slack utilised only produced in briquettes 1½ million tons. In Germany, during the same period, the production was 183 million tons of bituminous and brown coals; the slack utilised produced in briquettes and pressed blocks 14½ million tons.

The briquetting method of utilising coal slack requires a pressure of 200-1500 atmospheres, costly machinery and plant are constructed, and the slack has to be transported to the briquetting factories. The concreting process, on the contrary, enables the simple machinery and plant to be taken to the dumps of slack, thus saving at least one lot of handling and transportation. The concreted fuel is manufactured *in situ*. Further, it is submitted a better fuel is produced—one which lights from the sticks, incandesces and flares. The rough, fractured surfaces not only help in the ignition, but having more the appearance of Nature's coal they help in stimulating the confidence of the purchaser. It is even suggested that on board ship the bar-ashes from the furnaces and the coal dust from the bunkers can be easily concreted into a fuel with a calorific value of about 11,000 B.Th.U.'s.

The dumping of inferior grades of coal or other materials cannot strictly be regarded as waste up to the present, because never before has it been demonstrated that these materials can be employed usefully. Now that this process has been given every publicity, to leave these materials lying as rubbish when every effort is being strained to develop the resources of the country would be wilful waste.

It may appear rank heresy to the medical officers of health, but I appeal to the Local Government Board to order the closing down of the refuse destructors in many localities. The house refuse could quite well be collected in two different receptacles. The vegetable refuse during the war could be dumped, deodorised and afterwards used as a fertilising agent; the cinders and ashes, as before explained, could be made into a decent fuel.

In my own town of Eastbourne, a few months back great lumps of cinders existed which produce a concreted fuel of 7-8000 B.Th.U.'s. These are now being consumed, together with quantities of Welsh coal, in order to destroy the summer vegetable refuse. The transportation of this coal can be avoided, and the vegetable refuse after the war can be used to help improve the land. It is true that a certain amount of power is gained by destructor furnaces, but the amount of fuel required for this alone is nothing compared to the great consumption of cinders and coal required to destroy the house refuse.

It is said that one of the wonderful ways to win the war is—To help to save England's coal. Every individual can assist. It is shocking to walk through the City of London early any morning and to see outside almost every door buckets of ashes awaiting their removal to the destructor. Officialdom is, of course, very busy and overworked just now; lack of staff and increase of work easily accounts for that.

It is individual efforts that have built up the British race. We thrive best on a minimum Government control. Spontaneous efforts of all classes are to-day accounting more for our march to victory than the efforts of the best bureaucratic organisation in the world. The V.A.D.'s, the canteen workers, the munition workers, the allotment workers, the Women's Land Army, and, above all, our glorious Volunteer Army, will bring us an assured victory. Therefore we appeal to the individual to take part in a further effort to help to win the war—by reducing the transport of coal and by the utilisation of waste.

I shall fall out with nobody; the colliery proprietor will have at his disposal a process of reconstructing coal cheaper than any method at present in vogue; the industrial user will have available a fuel which can be made in a form that can be stored in the minimum of space and without danger of spontaneous combustion; and the householder will be able to clear his cellar to the last particle of dust and his grate to the last particle of cinders, and so produce his own home-made coal.

The town refuse yard, the gasworks, the brick and tile works, and others have thousands of tons of potential coal scattered up and down the land. The individual and the firm can help the country and themselves by tackling this question now, and so have plenty of decent fuel ready on the spots which are now only heaps of dust and ashes.

THE Education Officer of the London County Council reports, with regard to the training of munition workers, that during the two years ended June 30th, 1917, 8089 students have been under training in the various centres, of whom 6088 have been certificated on satisfactorily completing their training; 5751 of these are known to have obtained employment on work of national importance. The main centres at Brixton and Shoreditch have gradually been equipped with modern machine tools, some of which have been lent by engineering firms. The value of the machinery and equipment installed at the instance of the Ministry of Munitions is about £10,000. Five workshops are now in use at Shoreditch, of which three are equipped with modern overhead steel work. In these two centres the number of women trained has steadily increased, and women supervisors and storekeepers are now employed. The nature of the training has altered in character from the earlier efforts to train operators, to the training of setters-up, turners, oxy-acetylene welders, assemblers, and tracers. There are now comparatively few persons being trained as operators.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Finished Iron Trade.

THIS week business in the iron trade has been practically suspended. Production has been at a standstill at most of the works. Advantage will be taken of the holiday closing down to effect necessary repairs, which were naturally more extensive than usual owing to the conditions of stress under which works have been running. Apart from the temporary stoppage, demand continues excellent. Many consumers of iron find it useless to pursue inquiries, since orders are refused by manufacturers, who see no prospect of undertaking further business within the next two or three months. There are inquiries which if agreed to would go into next year for deliveries. Makers of best bar iron report severe pressure for deliveries. This class of iron is very firm at £15 10s. to £16 10s., and there are offers at £17 for special iron. Makers of "marked" iron hoops realise £18 10s. to £19. The only plates obtainable are for heavy washer making, for which a brisk demand is running. In wide strip sales are done at £15 15s. Buying of puddled bars is curtailed, as some makers have none to spare at £10 10s. per ton, and they could realise a higher figure for prompt delivery. An active trade is reported for thin sheets at £24 a ton for providing material for war work. A quiet demand rules for black sheets, as the galvanisers are in possession of only limited orders owing to the dearness of spelter. A considerable booking is announced of plain black working-up sheets at £22 per ton in connection with articles for military use. Galvanised corrugated sheets keep at £28 to £28 10s., and £29 per ton for 28 w.g. material.

The Future of Prices.

There is no apprehension on the Birmingham market that peace conditions will mean any reversion to the range of rolled iron values which prevailed when war began in 1914. This is good news indeed. The evidence afforded by the bi-monthly ascertainment of the Midland Iron Trade Wages Board, summarised by me in THE ENGINEER last week, that moderating influences are becoming felt in the upward movement of values is generally regarded by the Exchange here as a favourable symptom by the market. Inflation is not considered to be in the interests of a sound trade position. In the history of the trade there is nothing comparable to the prices now ruling. For the first time for over two years the advance during the bi-monthly period has been insufficient to give the ironworkers a rise of wages under the sliding scale. In those two years wages have been increased by 77½ per cent. The puddlers' rate, which was 9s. 6d. when the war broke out, is now 18s.

Pig Iron Trade.

Most of the pig iron houses are heavily booked. Here and there a more cautious attitude is being assumed with regard to further commitments, a waiting policy being favoured. Many of the smelters will still insist upon the condition that contracts shall be subject to any advance authorised by the Ministry of Munitions before their completion. Buyers do not like these qualifications, but the risk they run in this case is so lightly estimated that the condition is accepted. Nothing can be bought under maximum rates. The inquiry is strong for both forge and foundry irons, but especially for the latter. Calls of Staffordshire pig iron makers show that heavy parcels are desired, not only for district consumption, but also for Lancashire. Strong foundry iron is booked at £7 15s., and part-mine foundry at £5 2s. 6d. per ton, with £5 5s. offered in some cases for spot lots. For forge iron there are inquiries at £5 for Staffordshire and 95s. for Derbyshire iron. Northampton sales of iron are slow at 90s. to 92s., delivered.

Basic Material for the Steel Makers.

A great topic this week in raw iron circles hereabouts is the imminent change in the pig iron position owing to the insistent demand for basic iron. Some Midland furnaces are being requisitioned to help in increasing the output. It seems clear that smelters are to be left no choice but to convert furnaces which are at present turning out foundry and forge iron. The Ministry of Munitions has now become peremptory in the matter. It follows that the output of forge and foundry iron in the Midland and Staffordshire districts will suffer, and it will be a nice question to assess the relative claims of the home and export trades. Our exports to Allies have been on a large scale, so large that it has not always been easy to satisfy home requirements. As furnace owners are supplying pig iron only under the "A" Certificate the limits of possible compression are well defined. Smelters' representatives state this week that if many furnaces are to be put on to the production of basic it will be impossible to give deliveries on contracts at the present rate.

Raw Steel Trade.

Imports of American steel material are almost negligible. The dearth of semi-finished products is unrelieved. Blooms for re-rolling are quoted at over £20, which is prohibitive. A few hollow blooms have been bought at very high figures, but the trade does not amount to much. American wire rods continue to arrive in small quantities. The price here is £29 10s. to £30. Imports into this district of steel bar discards from South Wales realise £11 to £11 2s. 6d., delivered. All semis are scarce. The forwarding of blooms from the United States was short lived.

Steel Trade Extension.

An important ironworks change, pointing to extensive future steel trade developments, has just occurred in this district. Messrs. Bradley's Copperfield Ironworks, at Bilston, near Wolverhampton, consisting of blast-furnace plant only, have, owing to the advanced age of the principal partner, who is retiring from trade, changed

hands, and have been acquired by a small syndicate, which proposes in future to lay down a steel works, fitted with plant and rolling mills upon the most modern lines, to run in conjunction with the furnaces. Mr. Richard Thomas, the tin-plate magnate of South Wales, is understood to possess the leading interest in the new venture, and associated with him is Mr. J. W. Foster, the general manager of Messrs. Bradley's Darlaston Green blast-furnaces, near Wolverhampton, and one or two others. There is great and abundant room for the erection of additional steel rolling works in South Staffs at the present time, and the new concern has a prosperous career assured to it from the start.

Glass Industry's Progress.

Under the influence of the war considerable progress, as has previously been mentioned in this letter, has been made in re-equipping and re-invigorating certain branches of the glass trade in the Birmingham and Stourbridge districts, the extinction of which was being rapidly and very seriously threatened by German competition. The flint glass trade is one of the local branches in which marked revival is witnessed, and I am glad to record that there is now considerable confidence amongst the manufacturers that this industry, given a little more time for completing its new arrangements, will before very long be quite in a position to hold its own once more. Manufacturers in the flint glass trade have got something like six months' work in hand, so large are the arrears of orders. Substantial orders are being given out regularly by the Admiralty and the Ministry of Munitions, and everything points to a continuation of prosperity. Women are now taking a place as glass cutters for the first time in the history of the trade, and with, I am most happy to be able to announce, very satisfactory results. Female labour has also been brought in at other points of the trade, to make good the places of the many male workers who have been "called up" by the military. The advance of wages granted to glass cutters a short time ago has now been followed by an advance to the glass blowers. These men have received an increase of 1s. a turn, or about 9s. a week, making a total rise in wages and bonuses in the last eighteen months or so of close on 18s. per week. To go a little into detail, I may, perhaps, mention just here that one example of the local glass trade that has lately been rescued from German competition is the manufacture of pressure gauges. Aviation requirements have given a great stimulus to this branch, and important developments are now in progress. New and special machinery has been installed at certain of the district glass works for producing small pressure gauges under the most economical conditions, and little fear is now entertained of the foreign ascendancy being re-established.

LANCASHIRE.

(From our own Correspondents.)

Manchester, Thursday.

Iron, Steel, and Metals.

There is less business than ever this week in the iron and steel market, for a large number of people have this year determined upon taking a holiday, and the usual stoppage of business from Friday to Tuesday will be prolonged for nearly the whole of the week. Of course, the distribution of iron and steel against Government orders goes on as usual; but this is mechanical and a mere matter for clerks; it can be carried on quite well in the absence of the principals. In fact, the brains of a business are at a discount just now, and until freer conditions prevail they cannot be used to any extent. What is wanted is to concentrate all this brain power, which is being now wasted, upon the problem of obtaining freer conditions for trade.

Foundry Iron.

The local market for foundry iron has been very quiet this week in accordance with anticipation, but no anxiety is shown by sellers so far. The aggregate sales fully provide for the make up to the present, and signs of competition for orders are still wanting. The principal foundry irons offered are Derbyshire No. 3 at 98s. 8d., delivered, and North Staffordshire at 102s. 6d., but occasionally a lot of Northamptonshire is offered at about the same price as Derbyshire. Lincolnshire foundry remains off the market for the present. The large quantity of Cleveland foundry iron now being made does not affect the Manchester market; but recently some sales have been made up in the North of the county, where it can possibly compete in price with the Midland irons. Cleveland iron delivered in Manchester would be 1s. to 1s. 6d. cheaper than Staffordshire, and possibly if merchants were willing to take an interest in it some business might be done; but the Cleveland certificate still stands in the way, and merchants continue their policy of ignoring the existence of Cleveland iron. When the time comes, as it surely will, for makers of Cleveland iron to desire a re-entrance into the South Lancashire market, it will be found that consumers are thoroughly accustomed to other brands, and will require special inducements in the matter of price to lead them to any change of foundry mixtures. It is quite easy to lose a market for foundry iron, but regaining it involves many considerations besides price. The demand for Scotch foundry iron is very poor just now, but there is no large supply, and some sellers find a difficulty in getting prompt delivery of the small lots required. No. 1 Midland iron, which has been used a good deal in the place of Scotch for certain purposes, is not sufficiently plentiful, and more might be taken in this district if it could be relied upon so far as the supply is concerned. It should pay to endeavour to produce more of this class of iron in Derbyshire.

Steel.

One does not now come across any offers of finished steel for the benefit of the ordinary consumer who has no certificates and no Government orders on hand, and it is quite difficult to obtain finished iron. American material, whether finished or in the semi-manufactured state, is not offered now. There are still rumours that American steel is to be cheaper both for the Government of the United States and for the Allies; but the ordinary importer does not hope to get any business yet.

Scrap.

The demand for foundry scrap is said to be a little better; and one or two dealers again talk of raising the prices to a certain extent, although there is some danger in this course, for if the prices are put up unduly they may attract the attention of the authorities, and a position of affairs may be brought about similar to that which exists now in connection with wrought scrap. The latter commodity is simply held up by the loyal dealers; they cannot buy it at the maximum prices, and, of course, they cannot sell it. That some dealers are paying a good deal more than the maximum is common knowledge in the trade, and, in fact, circulars have been sent round offering more than the Government limits. What they do with it can only be guessed; but there is little doubt that the limits are being ignored in many directions. Whether the people who are thus carrying on business in defiance of regulations will be found out remains to be seen, but they cannot be blamed very much, because it is necessary that consumers should get some scrap, and they cannot get it unless someone oversteps the limits. Quite a similar state of things exists in connection with the trade in steel turnings. The official limit here is 50s. per ton on trucks, but recently a good deal of business has been reported at 60s. or thereabouts. The remedy is, of course, to abolish these absurd and unnecessary limits, and it is to be hoped that when those in authority come back from their holidays this will be done. Ordinary heavy steel scrap is dull and neglected here, and there is no inquiry for it either from Wales or from the North-Eastern district. It is said that very large quantities are being now consumed in both these districts, and it is probable that Lancashire scrap will soon be wanted again.

Metals.

The official prices of copper are unchanged, and the position in America does not yet seem to be cleared up, although there is hope of lower prices there. Tin has been easier, and merchants here quote £247 for English ingots, delivered in Manchester. For small lots of spelter £62 is asked.

The Engineers' Club.

After very carefully considering the respective merits of gas and electricity for culinary purposes, a special sub-committee of the Engineers' Club has recommended the adoption of electricity, and a range made by the Carron Company is about to be erected in the club kitchen. Before deciding upon electric cooking the members of the sub-committee had an opportunity of inspecting an "electrified" kitchen at Messrs. Howarth's cotton mill in Salford. Electricity has been in use there for some time, and the results have been completely satisfactory, both as regards cost and quality of the cooking, the cost working out at less than one-halfpenny per meal.

Waterworks Engineer Appointment.

I am informed that Mr. Fred J. Dixon, M. Inst. C.E., engineer to the Ashton-under-Lyne, Stalybridge and Dukinfield Waterworks, has been appointed engineer-in-chief to the South Staffordshire Waterworks Company, the headquarters of which are in Birmingham. This company serves the very large area of nearly 400 square miles, including some thirty-five towns, and the total population is nearly 1,000,000 persons. While he has been associated with the Ashton-under-Lyne undertaking Mr. Dixon has rendered very valuable service to the district, and has been responsible for many improvements in the water supply of this great manufacturing district, notably the installations of pressure filter plants.

The Holidays.

Most of the engineering works in this district are closed down altogether this week in order to give the operatives and staff a much needed rest. The week's cessation is being taken advantage to overhaul and repair the machinery, much of which has had a gruelling time for the past two and a-half years. In some districts near Manchester the holiday is not being taken until next week in order to conform with local traditions.

Barrow-in-Furness, Thursday.

Hematites.

There is nothing new to record this week in the general condition of things in the hematite pig iron trade of this district. On every hand there is marked activity, and a big volume of iron is being produced. There are thirty furnaces in blast and additional furnaces are wanted, but the difficulties in the way of so increasing the output have not yet been overcome, although it is hoped to augment the output of raw material in the immediate future. There has been no cessation of work on account of the holidays. For a few days the local consumption has eased down, but the works will be busy again at the end of this week, and in the meantime smelters of iron have plenty of outlets for their metal. Prices are unchanged, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton, and special brands at 140s. per ton f.o.t.

Iron Ore.

Iron ore mines have been having three days' holiday. The demand for ore is very brisk, not only on local but on general home account. Local smelters could easily take the whole of the output. More men are coming into the district to the mines, but many more are required, not only to work existing pits but to develop other beds of ore that are known to exist in both North Lancashire and Cumberland.

Steel.

In the steel trade there is industrial quietness this week, but the whole of the plant will be busily engaged on Monday next. The demand for semi-products is very heavy. Heavy rails are at £10 17s. 6d. to £11 per ton, light sections £14 to £14 10s., heavy tram rails £14, ship plates £11 10s., boiler plates £12 10s., and billets £10 7s. 6d. per ton.

Fuel.

There is a full demand for steam coal, which is at 25s. to 27s. 6d. per ton. House coal is at 27s. 6d. to 37s. 6d. per ton delivered. Coke is in heavy request, with East Coast qualities at 33s. to 35s. 6d. per ton, and Lancashire cokes at 31s. per ton delivered.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

The Cleveland iron trade position continues very firm and steady. The allotments for the current month are fully adequate to meet requirements, and with iron in good supply the quantities allowed are being covered without difficulty. Forge iron is in good request, particularly from Scotland, where consumers have found that it can be advantageously mixed with the foundry qualities for many purposes. Substantial forward buying of this description of iron is reported. On the export side, the tonnage situation is still tight. There is a heavy demand from the Allies, and fair quantities are being got away. The exports of pig iron from the Cleveland district during July amounted to 52,733 tons, of which 1945 tons were sent coastwise, and 50,788 tons went abroad, as compared with 60,638 tons in June, a decrease of 7905 tons. The total for July, 1916, was 54,311 tons. The home maximum prices are unaltered at 92s. 6d. for No. 3, No. 4 foundry, and No. 4 forge; and 96s. 6d. for No. 1. The export quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

There is no change in the general conditions of the hematite pig iron trade this week so far as the North-East Coast is concerned. Notwithstanding the stringency, adequate supplies for all current needs are going forward to home consumers. On the export side the question of price is still a source of trouble and uncertainty, as no official decision is yet to hand. But merchants are shipping at the old prices on the understanding that any readjustment should be retrospective. Nominal export prices are 137s. 6d. to France and 142s. 6d. to Italy. The home price remains unchanged at 122s. 6d.

Iron-making Materials.

In the foreign ore trade deliveries have of late shown improvement, but the demand is as insistent as ever. There is a heavy demand for coke, and though there is much on the market values are well upheld. Descriptions needed for the blast-furnaces in the North-Eastern district command full rates, average sorts realising 28s. at the ovens, and qualities low in phosphorus 30s. 6d. at the ovens.

Manufactured Iron and Steel.

It is definitely settled that the workpeople of Tees-side and Cleveland will have their customary August holiday, and the majority of the works will close down for a full week, commencing on the 18th inst. The large volume of trade being done in steel shows no signs of cessation, and the situation is unchanged generally. All the output is being taken by the Government either directly or indirectly, and very little in the way of ordinary material is passing through. Large quantities of steel material are being used in the shipyards, where the work placed by the Shipping Controller proceeds with much activity, the precision with which supplies are being delivered enabling work to be carried on with the utmost dispatch. The manufactured iron trade continues to run at the highest possible pressure, makers having an unlimited supply of orders for both their iron and steel departments. Every mill is kept busily employed producing an extraordinary output, the bulk of which is required on Government account, the demands of the ordinary consumer being held subsidiary. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export: Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, $\frac{3}{8}$in. and upwards, £13 10s.; $\frac{5}{16}$in., £13 15s.; $\frac{1}{4}$in., £14; $\frac{5}{16}$in., £16; $\frac{1}{4}$in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent. except ship plates, angles, and joists, packing iron, and iron bars.

Scrap.

There is no change of importance in the position of the scrap trade this week, although the demand for steel scrap is perhaps somewhat less acute, some consumers now being well covered. Cast iron scrap is steady without much actual business. There is a very strong demand for heavy wrought iron scrap, and the absence of business is merely the result of the refusal of holders to take the legal maximum. Buyers would be glad to obtain the material, and could no doubt absorb large quantities, for wrought scrap at the authorised price is a bargain for the iron manufacturer. Dealers, however, know this as well as buyers, and are prepared to wait until a better price is allowed. Current prices are:—Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, $\frac{3}{4}$in. thick and over, £6 5s.; heavy wrought iron scrap, $\frac{1}{4}$in. thick and over, £5 5s.

New Shipbuilding Yard.

It is understood that the negotiations which have been in progress for some time past with regard to the establishment of a new shipbuilding yard on the Wear have been completed. The site for the yard is situated at Pallion, Sunderland, and adjoins that of Messrs. Short Brothers. Sir John Ellerman, the well-known shipowner, of London, is mentioned as the chief partner, and among others interested are Messrs. Gray, of Hartlepool. The yard will accommodate four berths, one of which will take a vessel over 600ft. in length, while the launching space in front is one of the best on the river.

The Coal Trade.

Operations in the Northern coal trade are more restricted than ever, and the outlook is anything but promising. With the unsettling effects of the new export regulations, the fear of detrimental changes following on the Coal Transport Order, business is almost reduced to a standstill. The new schedule prices work out in favour of the best coals and to the detriment of the second qualities, which have been advanced in price under the new scale to an extent that makes them relatively dear to the best brands. Hence there is not the demand for such second class and inferior coals, and the collieries producing them are bound to suffer. Several, though not all, of the doubtful points which have arisen out of the Coal Control Regulations have received further consideration, and are now practically settled. To the dismay of middlemen, it has been decided that coal held on contract cannot be sold to shippers for export at below the schedule prices. The decision involves the whole question of arrears of contracts, which, in its turn, is now receiving the attention of the Controller, and is a matter of first importance to the trade. The question of fittage on bunker coal has been settled by the Controller ruling that all bunker coal sold to neutral ships, or even Allied ships for neutral destinations, must pay a minimum of 5 per cent. fittage commission, but that in the case of bunker coal for Allied destinations, whether supplied to Allied or neutral ships, the fittage may be mutually arranged. Shipowners who buy direct from the collieries, however, are to be under no obligation to pay this fittage. Bad as the coal trade is now there are fears that it will be worse in September, when the new Coal Transport Order comes into operation. Under this Order Northumberland is only to send coal into Durham and Cumberland, and Durham into Cleveland and Cumberland. It is impossible that the requirements of Cumberland and Cleveland can be sufficient to keep the pits of Northumberland and Durham going, and unless more coal can be sent to London by sea, and the export trade generally increased, there is the poorest prospect before the North Country collieries. Quotations are as follows :—Northumberlands : Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade ; 28s. 6d. to 30s. for export ; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams : Steam (locomotive) 28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; best, 25s.; superior, 30s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SHEFFIELD.

(From our own Correspondent.)

An Interesting Tribunal Case.

So far as work is concerned the past week has had to be practically written off. Everywhere operations were suspended until Wednesday, but most firms had not arranged to resume until the following day, and many will not recommence until Monday, for the reasons explained last week. The weather has enabled munition workers to take full advantage of the holiday, on the eve of which a very interesting case was heard at the South Yorkshire Appeal Tribunal held here. The facts briefly were that a local firm of steel plate makers appealed for three men on the ground that they were indispensable in a business like which there was no other in the world. The men, it appeared, were employed in making plates from steel hardened in a special manner, the plates being used in the operation of printing Bank of England notes, Treasury notes, Exchequer bonds, &c. The manufacture of the plates requires the employment of a team of men, whose training takes at least six years, so particular is the work that the least flaw in a plate means that it has to be scrapped, and what that involves was explained in the statement that each plate takes £100 worth of work. The firm had in hand orders for banks in Australia, Canada, Egypt, Belgium, the United States, Italy, and Portugal, as well as home contracts, and if it lost a man it was impossible, it said, to replace him, even by a woman. Firms in the United States, it was contended, had tried to make these special plates, but unsuccessfully. On these grounds it was asked that exemption certificates should be granted for three men claimed by the military. All the men in the firm's employ, with the exception of these three, had been exempted, and it was claimed that they were just as important as the others. The Military Representative submitted that the Munitions Army Recruiting Office had not granted the three men certificates of exemption ; but in the end the case was adjourned until next week, the firm's representative stating that it was in communication with London, and hoped to secure exemption.

How Munition Workers Give.

When so very much is heard of the high wages earned by some of the munition workers, it may be of interest to mention the care shown by many of them for their comrades in khaki. Numerous instances of this could be given, but an account recently issued by officials of a local National Projectile Factory furnishes a very good idea of what is going on. This shows that during the past year the contributions of the staff and workpeople totalled close upon £2000, enabling the Committee to make several handsome donations, the chief being nearly £1500 to the Third Northern General Hospital and extensions. Other help was also rendered, including such gifts to the wounded as 220,250 cigarettes, over 400 briar pipes, 124 lb. of tobacco, 2500 apples, 2500 bananas, 2000 oranges, 1600 tins of fruit, 560 lb. of grapes, 520 lb. nuts, 466 lb. of jam and marmalade, 3900 lb. of bacon, 500 lb. of ham, 500 lb. of plum pudding, and huge quantities of hosiery, stationery, &c. The cost of administration of this fund was a mere bagatelle. This matter, I thought, was worth mentioning, because it shows that, under the wise guidance of the management of our large steel concerns, the armies of munition workers, quite unnoticed by the ordinary public, are doing good service to wounded soldiers, and taking a real pleasure in the work. It is not too much to say that many of these people are learning for the first time in their lives, perhaps, how to give systematically and practically to those needing help, and it is unlikely that the lesson being so well inculcated will ever be forgotten.

A Big Sewage Problem.

A subject that is creating a good deal of interest, particularly in engineering circles, is a new proposal for the joint treatment of the sewage of Sheffield, Rotherham, Chesterfield, and adjacent places. The proposal, I believe, was originated by Mr. Charles Markham, brother of the late Sir Arthur, and head of the Broad Oaks Ironworks, Chesterfield. Mr. Markham has large colliery and engineering interests in Yorkshire and Derbyshire. It is only quite recently that a conference of representatives of the three districts named was held in Sheffield, with Mr. Markham in the chair. What was then advocated was a joint board to control not only sewage but water, gas, and electricity, it being suggested that such a central authority could deal more satisfactorily with those questions within the limits of the area indicated. There was some free discussion, and ultimately the representatives present agreed to lay the scheme before the respective authorities, and to recommend the appointment of a small committee for the purpose of making full inquiry, and, if necessary, of engaging expert advice on the practicability of carrying the sewage of the areas named to the lower reaches of the Don, and to ascertain the cost of such a scheme. So far as Sheffield is concerned, should a plan of this kind be adopted, a very large site at Blackburn Meadows, in the heart of the great steel manufacturing centre, would become available for building operations, and would prove a valuable acquisition for some of the larger developing firms. Quite forty years back a scheme was propounded for carrying the sewage of the district to the sea by means of a main arterial sewer to be laid to the Humber, and so taken out to the North Sea, but after being viewed favourably in likely quarters it was allowed to lapse.

The Joint Scheme.

Mr. Markham tells me, however, that his scheme does not at present deal with the question of what is to be done with the sewage when it has been got down to below the Doncaster area. "Of course," he adds, "this is a problem that can only be solved by long and careful study, and it is one that I have particularly avoided at present, as the question of whether mechanical filters or filter-beds should be installed is one that would require a good deal of thought." His idea is really that under a joint scheme the sewage for the three main districts would be rough-filtered instead of, as at present, being treated with lime or other substances, which make it absolutely valueless for manurial purposes, the present product of the sludge press being, in the opinion of very many, not worth putting on the land. With Doncaster only about 16ft. and Armthorpe less than 12ft. above sea level, Mr. Markham's point is that, when coal in that area is worked out, the land will provide a natural dumping ground for the sewage. To make the scheme really successful the whole of the drainage in the valleys of the Don and the Rother should be dealt with, and practically no pumping would be required, whereas any plan for piping sewage to the sea would mean pumping at enormous cost. The sewage would all be got rid of by gravitation, and the stuff, once at its destination, would be left for the liquid to filter and the mud to precipitate. Those who favour it hope that if the proposal materialises towns like Barnsley, Mexborough and Swinton may be induced to join in the scheme, in which case the sewer-pipe would start with a comparatively small diameter at Chesterfield and increase its size as it advanced down the valley.

Cheaper Electricity.

It may be recalled that in a recent letter I referred to suggestions made in influential quarters for the provision of electrical power at a very cheap rate. Mr. Markham favours a scheme of that kind strongly, with a central power station, as previously shown, close to the South Yorkshire coalfield. In a smaller way, the Staveley Coal and Iron Company has done something of the kind, thus proving its practicability. He can see a great saving if the coal used for generating electricity were obtained on the spot, whilst the fact of one large plant instead of a number of smaller ones would also mean economy. Mr. Markham finally points out that means for disposing of boiler ash would have to be at hand and a good water supply is essential. The latter is assured, for at the Bullcroft Main Colliery, right on the spot, 3600 gallons of good water are pumped out every minute, the water rising to within a few feet of the surface, making pumping easy, whilst another pit supplies water to Lincoln and other towns. The result of the recommendations of the representatives at the recent joint meeting to their respective authorities will be awaited with much interest, though whatever is decided upon, or favoured, can, for the present, apparently, refer only to the sewage question, not to the electricity scheme, the latter, I believe, having been shelved until after the war. When, however, the way is clear, the demand for cheap electrical power will be almost illimitable. Great developments may be anticipated at the collieries themselves, whilst in Sheffield and other industrial centres concerned, the adoption of the new power is making almost daily progress. Some such scheme must sooner or later force itself to the front.

Increased Wages.

No one can say that in these days the workers are being neglected in the matter of wages. The report submitted at a meeting here on Saturday of the National Amalgamated Union of Labour showed that during the past three months wages gains had been secured amounting to nearly £90,000 per annum, affecting just over 8000 members. During the quarter, it seems, the membership had increased by more than a thousand, and there are now over 20,000 financial members, beside 4000 in khaki. The report complained of delay on the part of the Government Contracts Department, in taking notice of complaints from the cutlery trade, but added that it was only fair to say that that did not apply all round, either in the cutlery or other Sheffield industries. Taking the majority of the members and the majority of the industries in which they were engaged, where negotiations could be conducted directly with the employers and employers' associations, the workers' representatives were able to secure fair and reasonable treatment, ending in settlements satisfactory to both sides. The secretary of this particular union has an excellent reputation for reasonableness in negotiations about trade disputes, but it is such statements that give hope of permanently improved relations between Capital and Labour, one of the essentials of sound reconstruction. At the Council meeting of the Yorkshire Miners' Association on Monday, however, the feeling was less reassuring. A strong opinion was expressed that unless a different attitude is taken up by the coalowners with regard to the carrying out of agreements, the non-union question, surfacemen's wages, hours, and conditions of work, and abnormal places, they would be compelled to take a county ballot at the very earliest date. Some sections of the miners seem always looking for trouble, always threatening a ballot—in other words, a strike. Coalowners find their path strewn with difficulties, and if there is a possibility of a misunderstanding arising, it appears to materialise every time.

Fuel.

In consequence of the holidays there is little or nothing to be reported regarding the iron and steel markets, and steam coals are in much the same position. Shipments to Allies, however, are receiving full attention, and the Government's naval demands keep heavy. Slacks are not quite so active, and house coals are practically unchanged, though, on the whole, supplies at depôts are coming in more freely, though not at all equal to requirements. Best South Yorkshire steam hards are quoted 17s. 6d. to 18s.; best Derbyshire hards, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 17s.; nuts, 16s. 6d. to 17s. 6d.; best hard slacks, 12s. to 13s.; seconds, 12s. to 12s. 6d.; soft nutty slacks, 12s. to 12s. 3d.; pea slacks, 10s. 6d. to 11s.; and small slacks, 6s. to 7s., all per ton at pit. In house coals, branch is quoted at 21s. 6d. to 22s. 6d., and best Silkstone 18s. 6d. to 19s. per ton at pit.

SCOTLAND.

(From our own Correspondent.)

Distribution of Household Coal.

During the past few months the question of deliveries of household coal has claimed considerable attention, and the proximity of the winter season has brought the matter into greater prominence. There is little doubt but that supplies will be sufficient, the difficulties anticipated being in the nature of a shortage of labour, wagons, and horses. A large number of the latter have been requisitioned for national service. It has been pointed out, too, with reference to about one hundred representative firms in the Glasgow district that pre-war staffs to the number of 1758 in the aggregate had been depleted by 478, leaving 1280 inclusive of new war-time workers.

Manufacturers' Coal.

The new regulations confining the distribution of coal to districts have given rise to considerable dissatisfaction. For instance, manufacturers in the south of Scotland, who formerly drew their supplies from North of England collieries, will have to arrange for coal from their nearest Scotch depôt, thereby entailing much larger railway carriage. Representations have already been made on the subject, and the Board of Trade Coal Mines Department replied, stating that it did not think it would be in the national interest to depart even in this instance from the general principle, viz., that no coal would be imported from England to Scotland by rail.

Pig Iron.

The conditions governing the pig iron trade show little alteration; outputs of hematite are reserved for Government work. Foundry qualities, too, are becoming very scarce, while forge iron is not always obtainable. There is little or nothing being exported, as everything is being used for home consumption, and shipments are mostly confined to small consignments to the Allies. Prices are firm and unchanged.

Quotations.

Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

The pressure on the iron and steel manufacturing works is ever increasing, and despite additions to plants, arrears continue to accumulate. Government orders for steel are very plentiful, and it is almost certain that

ordinary mercantile supplies will be even less in future. Limited quantities are being shipped to France and Italy. Prices are firm and unchanged. Black sheet makers are working under great pressure, especially for delivery of the heavy gauges, and there is little possibility of securing anything outside the limits of a priority certificate. The price is still in the vicinity of £18 5s. per ton, net, f.o.b. Glasgow. Galvanised material is still a prohibitive luxury so far as ordinary consumers are concerned. Malleable iron makers have a large number of orders on hand, as everything possible is now taken in iron owing to the impossibility of securing steel. Ordinary commercial work is greatly in arrears both in steel and iron. Both at the engineering shops and at the shipyards outputs are on a high level.

Coal.

The Scotch coal trade remains dull and lifeless, and there seems very little prospect of an improvement under present conditions. The restricting of exports has dealt a severe blow at the Scotch trade, especially in the East of Scotland districts, where the export department formed the principal outlet. In the West of Scotland district work at the collieries is fairly general, but apart from a good industrial demand business is rather stagnant, and stocks have a tendency to accumulate. Prices are as follows :—Ell coal, f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. In the Lothians district great difficulty is experienced in disposing of outputs. Quotations remain on last week's level. First-class steam coal, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The situation in Fifeshire is still far from encouraging. The miners are only getting from two to three full days' work in the week. First-class screened navigation coal is quoted, f.o.b. at Methil or Burntisland, 29s. to 31s.; unscreened, 24s. to 25s.; first-class steams, 28s.; third-class steams, 24s. per ton. The aggregate shipments from Scottish ports during the past week amounted to 137,003 tons, compared with 123,764 in the preceding week, and 194,500 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Something in the nature of a fresh upheaval in the coal trade has been caused by the proposal of the Coal Controller regarding arrears on contracts. The policy adopted by coalowners towards their contractors has always been of a give-and-take character. The quantity of arrears and their price have been factors in the arrangement of new contracts. Old and new contracts have been what is known in market circles as "married." Arrears have been accumulating since the start of the war, and in all cases it depends upon where exporters are shipping coals as to whether they will be able to lift any of their contract supplies. But the Coal Controller is not prepared to let things go on as they are, while he is responsible for the mines; it is his intention to cut out as far as possible these arrears. Exporters are naturally concerned as to how the scheme will work out. Individual circumstances will govern each case, but their grievance is that the Coal Controller is not adhering to his scheme of June 28th last, which definitely stated that the following contracts were not to be interfered with :—(*a*) All contracts entered into before May 1st, 1917; (*b*) existing contracts for purchase of coal or coke which has already been sold or re-sold—(1) to consumers in the United Kingdom, (2) to purchasers abroad, (3) to shipowners for bunkering their own steamers, and (4) to manufacturers of coke-oven coke and patent fuel. The new scheme of the Controller is that existing contracts on which there are arrears in deliveries outstanding on June 29th last shall be submitted to local committees constituted of three coalowners and three exporters, for the purpose of deciding whether such arrears may be supplied at the contract prices or are to be cancelled. These committees are instructed to take certain conditions into consideration, and these are : (1) whether the coal was already sold abroad (or in the case of bunkers to shipowners) prior to the 29th June, and there is an obligation in the contract to deliver; (2) whether arrears were due to colliery owners' fault or arrangements with colliery owners; (3) whether any deliveries were made during the three months prior to June 29th last; and (4) whether the purchaser, while failing to take deliveries, has bought improperly elsewhere. The Coal Controller suggests that the committees shall also bear in mind that (*a*) lack of tonnage cannot in itself be regarded as establishing the claim to the delivery of arrears; and (*b*) generally speaking, arrears of speculative contracts should be cancelled. Cases which cannot be settled by the committees can be referred for final decision to some person agreed to by the committees; or failing agreement to the independent member of the District Coal and Coke Supplies Committee.

Coalfield Wage Rate.

Mr. Finlay A. Gibson, the secretary of the Monmouthshire and South Wales Coalowners' Association, has issued a statement to the effect that at a meeting last Saturday week of the owners' representatives on the Conciliation Board, the report was received from the joint accountants giving the result of the audit of selling prices for three months ending June 30th last. This is the third audit taken since last September, and like the two previous audits, showed a reduction in the average prices compared with those in the September quarter of 1916. On the ground of this reduction in price and the increased and continuously increasing cost of production, it was decided, subject to the approval of the Controller of Mines, to apply to the workmen's representatives for a reduction in the general wage rate. This decision was in due course formally communicated to the Controller, who, however, has replied stating that no application for a reduction in the general wage rate should be made at present. While abiding by this decision, the owners desire to draw attention to the fact that in February last, as now, they were entitled to a reduction owing to the fall in the average selling prices of coal alone, and without taking into account at all the heavy increased cost of working. It is only at the direct request of the Controller that they have once more refrained from applying for a reduction in the general wage rate, and this course is followed without prejudice to their future position.

Miners and Recruiting Scheme.

Last week-end a special conference of delegates from the coalfield, in addition to discussing a peace resolution, recommended by the Executive Council of the South Wales Miners' Federation, considered and rejected the scheme of the Mining Association and the Miners' Federation of Great Britain for supplying men for the Army. The scheme provides for taking 21,000 men from the collieries throughout the whole country, and of this number the quota for South Wales is 4575. The Conciliation Board is to allocate the number to be taken from each colliery from among unmarried men between eighteen and twenty-five. Some of the delegates contended that the organisation of the Miners' Federation should not be used for providing men for the Army. The voting showed that there were 236 against the scheme and 25 for its adoption. Subsequently the conference resolved to take a ballot of all the members upon the procedure to be adopted to give effect to the resolution rejecting the comb-out scheme, and asking the Government not to put the scheme into operation until the ballot had been taken.

Outlet for Inferior Smalls.

At the end of last week the Cardiff Coal Washery, which had been closed almost since the commencement of the war, was reopened. For a time the quantity of smalls dealt with will not be very considerable, but it is hoped that when arrangements are more advanced the supplies treated will be very extensive, and that the difficulties regarding the small coal problem will be to some extent minimised. The washery was erected some years ago by the Cardiff Washed Coal Company, Limited, and the washed products were shipped to Italy, there being Italian interests in the undertaking.

Newport Water Scheme.

The Newport Corporation has considered in Committee the proposal of the Waterworks Committee, to proceed with an application to Parliament for powers to carry out the Talybont scheme; but it was decided by eighteen votes to five to consider the report in twelve months' time, and in the meanwhile the Corporation will get further particulars as to the quantity of water which the Merthyr Corporation will be able to supply. It was reported that whereas on the estimated pre-war basis the cost of a new reservoir at Talybont was £600,000, the present price estimate was not less than £750,000, which, it was calculated, would involve a charge on the town's finances of £43,000 annually.

Colliery Examiners.

Members of the South Wales and Monmouthshire Colliery Examiners' Association have had under consideration questions (1) whether a ballot should be taken in favour of tendering notices on September 1st, with a view to enforcing recognition of the association by the coalowners; (2) an uniform wage; and (3) what action should be taken in case of strikes on the part of the workmen. The members displayed a strong feeling that officials should assert their rights in the same way as workmen. It was stated that some colliery owners had conceded the demands made by the officials as regards wages, but that the Coalowners' Association did not, so far, recognise the association, with the result that there was no uniformity either in wages or in the conditions of employment. The decision eventually come to was, that in the case of a dispute between the owners and workmen, members of the association should do their best to keep the pits open during negotiations by performing such duties as they consider pertains to their position, such as preventing all falls of roof and sides, the clearing away of falls that would have the effect of impeding ventilation, but that they should perform no work of any kind on the surface, mechanical work underground, or the feeding of horses.

Current Business.

There has been no business of any importance since about the middle of last week. Efforts were chiefly directed to getting cargoes away before the holidays, and completing arrangements for those immediately following. The Exchange was closed for the first two days of this week, also on Wednesday afternoon; but nothing much could have been done, seeing that collieries had only stocks to deal with, and these were being reduced very substantially towards the end of last week. It was generally expected that as the miners were having three days off that there would be very little coal about, and seeing that numbers of the men would probably extend their leave of absence, the chances are that production this week will not amount to more than 30 to 40 per cent. of normal supplies. Under these circumstances superior grades were almost unobtainable. Values all round were nominal, and conditions will not be settled before next week.

Later.

There is no change in the conditions governing the market, and business is a good way from being settled. Coals are tight, as stocks have been worked down. Patent fuel is quoted at about 30s., and pitwood rules round pre-holiday values, viz., 58s. to 60s.

Schedule Prices.

Steam coal : Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Western Valleys, 29s.; seconds Western Valleys, 28s. Bituminous coal : Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. Coke, 47s. 6d.; pitwood, ex ship, 58s. to 59s.

Newport.

The market has been entirely under holiday conditions, and business has been practically at a standstill. Shipping operations have been more satisfactory than was expected, and there are prospects of a steady demand ruling throughout this month and of work at the collieries being much more regular than in the past. Schedule prices :—Steam coal : Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coal : Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s.; pitwood, ex ship, 58s. to 60s.

Swansea.

The approach of the holidays brought along a rather better inquiry for some descriptions, more particularly machine made qualities, and nuts and beans have moved off well. Since the resumption of work, business has been rather quiet and unsettled, though the tone is better than was experienced last month. Schedule values :—Anthracite : Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 10s. Steam coal : Best large, 30s.; seconds, 27s.; bunkers, 25s.; smalls, 19s. Bituminous coal : Through and through, 27s.; smalls, 24s.; patent fuel, 28s. to 30s.

Tin-plates.

There is no work throughout the tin-plate trade this week, which is being observed as the usual annual holiday. The trade has been very active, and is likely to continue so after the holidays. Orders are very numerous and are in excess of what makers can deal with. Values of tin-plates are fixed on the basis of 30s. per box, free on rail, for I.C. 14 × 20 × 112 sheets. Quotations :—Block tin, £247 per ton cash; £243 5s. per ton three months; copper, £125 per ton cash; £124 10s. per ton three months. Lead : Spanish, £30 10s. per ton.

AMERICAN ENGINEERING NEWS.

ACTIVATED SLUDGE PROCESS FOR SLAUGHTER-HOUSE WASTES.

The enormous amount of refuse from the great stock-yards and meat-packing district at Chicago has been a serious phase of the sewage-disposal problem, and the city finally insisted that the stockyards and packing-house interests must do something to remedy the condition. After a period of experimentation a committee representing these interests and the city has recommended an activated sludge plant, having a capacity of 50,000,000 gallons daily of combined sewage and industrial wastes. The material would be passed first through a combined grit and grease chamber, a series of coarse and fine screens, and then a second grease chamber. The aeration of the screened sewage would be done in continuous-flow tanks, using 4 cubic feet of air per gallon of sewage, with an 8-hour period of contact of the sewage and activated sludge. The aeration tanks will have Filtros plates, with 16½ ft. of sewage over the plates, wooden baffles forming three longitudinal channels. From the aeration tanks will pass to settling tanks of the Dortmund type, and the liquor from these will be a stable effluent suitable for discharge into the drainage canal. To handle the great quantity of very liquid sludge a preliminary settling will be followed by filter pressing and drying by heat. The filtrate from the presses may be added to the fresh sewage entering the plant. The sludge from the presses will contain about 75 per cent. moisture, and this can be reduced to 10 per cent. in the driers. The cost is estimated at £760,000, with an annual cost of £165,000 for operation, maintenance, interest, and depreciation. To offset the operating charge an annual revenue of £30,000 to £90,000 per year from dried sludge and grease is estimated.

ALCOHOL FROM GARBAGE.

A new development in the utilisation of garbage is the extraction of alcohol, under a process patented in the United States. American garbage is relatively rich, and experiments conducted for a year at Columbus indicate 5 gallons of 95 per cent. alcohol of good quality can be obtained from one ton of the green garbage of that city. It is estimated that with works costing £7200 the treatment of 20,000 tons of garbage in one year would produce 96,000 gallons of alcohol, with a profit of 1s. 9d. per gallon at war prices, or 1s. 3d. under normal conditions. The new Morgan process consists of extracting grease from the garbage by cooking it with sulphuric acid and steam, thereby converting the starch and allied products to dextrose. The grease is then separated from the tank liquor, and the acid neutralised sufficiently to allow of fermentation. The liquor is fermented with yeast, converting the dextrose to alcohol, and the alcohol is then recovered by distillation. The steam cooking is done for two hours at 60 lb. pressure, and after the liquor has been pressed out the solid matter is dried and made into tankage. The neutralising of the liquor is done with caustic or hydraulic lime, and the resulting precipitate or sludge is added to the tankage. The fermentation proceeds for from thirty-six to seventy-two hours. The figures of cost and profit do not include the cost of finishing processes for the grease and tankage, nor the revenue from these two products. The yield of both of these is less in quantity than by ordinary garbage-reduction processes, but it is thought the loss of tankage would not be great, and that there would not be much less in quality or quantity of grease. Similar processes have been tried, but with less satisfactory results than with the new process.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

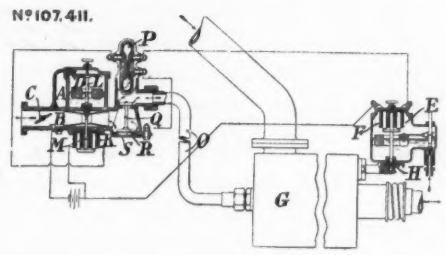
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

107,411 (8980 of 1916). June 26th, 1916.—Fuel Supply Mechanism, Gogu Constantinesco, the Haddon Engineering Works, Honeypot-lane, Alperton, Middlesex.

The object of this invention is to provide means by which an engine may be started, say, on petrol, and automatically switched over to paraffin when the engine and vaporiser have become sufficiently hot. A is the petrol carburetter in the inlet passage B and C is the throttle valve, E is a paraffin float chamber in which the paraffin is kept at a constant level above the outlet, and this float chamber is controlled by an electro-magnet which allows the fuel to supply the vaporiser G through the valve H when the magnet is energised. A second control for the petrol is provided, consisting of an electro-magnet K adapted when energised to cut off the petrol supply. Petrol may thus

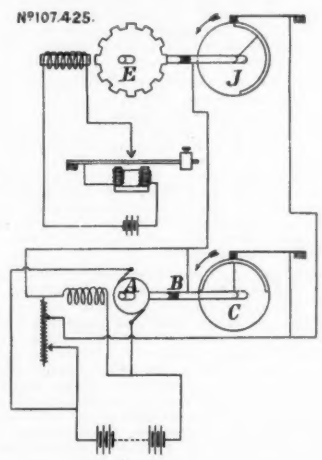


be cut off either by the valve spindle L operated by a diaphragm D or by a second valve spindle M operated by the electro-magnet K. From the vaporiser G a passage O is provided leading to a thermostat P, and from the thermostat through a light lift valve Q to the induction pipe of the engine. This light lift valve is provided with a disc R adapted nearly to close an air inlet, the valve being so arranged that it is lifted when there is moderate suction in the engine. The valve spindle rests on a contact S, which prevents any current passing in the circuits of the electro-magnets unless the valve Q is open. The lift valve is thus so arranged that it cuts off communication between the engine and the passage O leading to the vaporiser G unless there is a certain suction in the induction pipe B of the engine, so that this valve G prevents a too rich mixture of paraffin and air from passing to the engine.—*June 26th*, 1917.

TELEGRAPHS AND TELEPHONES.

107,425 (9165 of 1916). June 29th, 1916.—Speed Control of Direct-current Motors, Marconi's Wireless Telegraph Company, Limited, and another, Marconi House, Strand, London, W.C.

The inventors mount upon the shaft A of the motor to be controlled, which is preferably shunt wound, a disc C, part of the periphery of which is formed of insulating material, while part is formed of conducting material. The inventors mount a similar disc J upon the shaft of a constant speed motor E driven by means of an electrically maintained tuning fork, vibrating reed or gas relay. The resistance of the field circuit



of the motor to be controlled is so connected to the conducting strips on the two discs, and to brushes adapted to contact with the strips so that, whenever either of the strips is beneath its brush, part of the resistance is short-circuited. The resistance is so arranged, that when the motor to be controlled is running at the same speed as the constant speed motor, the strip on the disc of the motor to be controlled may have a lead over the other strip of approximately half the angle subtended by either strip at the centre of its disc.—*June 29th*, 1917.

DYNAMOS AND MOTORS.

107,512 (15,597 of 1916). November 1st, 1916.—Commutators, Vero Marshall Allen, Cantley, Harboro-road, Ashton-on-Mersey, Cheshire.

The object of this invention is to provide an improved construction of cummutator, whereby a larger number of bars can be included than is usually possible. As will be seen from Figs. 1–3, the bars A B have necks C D which extend outwards and form with the necks of a series of similar commutator bars a ring of necks extending between the dotted lines E of Fig. 1. This ring of necks is nearer to the armature core than the necks of the remaining commutator bars, one of which is indicated at F having a neck G which, with the necks of other similar bars, forms a ring extending between the dotted lines H of Fig. 1 further from the armature core than the necks forming the ring E. The bars, of which A and B are examples, are arranged alternately with the bars of which F is an example, and the leads J from the armature conductors which are to be connected to the neck G pass between the necks C and D of the bars A and B, being insulated at this point by insulating material K. It will

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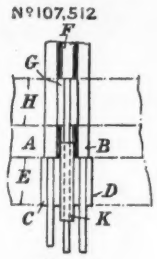

Fig. 1.

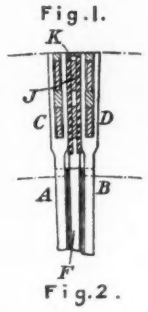

Fig. 2.

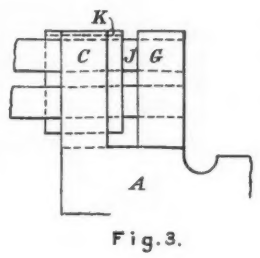

Fig. 3.

be seen from Fig. 2 that the necks of the bars A and B have a greater width measured circumferentially than would be the case if the neck of the bar F were arranged between them, since, after allowing for the necessary thickness of insulation, it is only necessary to provide space for the conductors J to pass between the necks, the neck G to which said conductors are connected being arranged in the ring of necks which is further from the armature core than the ring which contains the necks C and D.—*July 5th*, 1917.

AERONAUTICS.

107,519 (16,403 of 1916). November 16th, 1916.—Propeller, Thomas Dunlop Garscadden, 139, Meadow-lane, Loughborough, and another.

This invention is for an improved propeller to accelerate the speed and climbing power of aircraft, and provide a practical working basis of design. Fig. 1 is a "chord angle" diagram, and Fig. 2 a plan of the blade, while Fig. 3 is a diagrammatic end elevation of Fig. 2. To determine the chord pitch-angles at several radii along the blade—see Fig. 2—a base line is drawn, A B—Fig. 1—equal in length to the circumference corresponding to screw diameter. At a point two-thirds of the distance from A to B a perpendicular line C D is drawn to the base line, having for its length the "mean pitch" of the screw. From point D a straight line D E is drawn at any angle greater than 90 deg. to the line C D, terminating at E in a perpendicular

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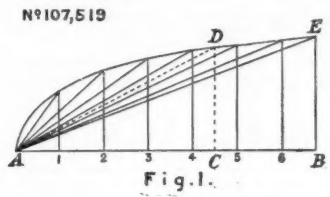

Fig. 1.

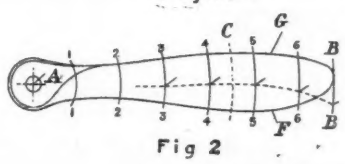

Fig 2

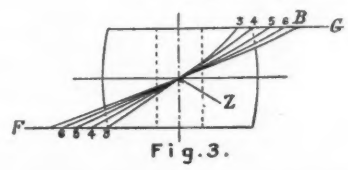

Fig. 3.

drawn from the end of the base line at B. From point D, and tangential to the line D E, an involute curve is drawn to point A on the base line, the curve having the centre of its originating evolute normal to the base line A B at the point A. This point A represents the centre of axis of the screw. The base line is now divided into any convenient number of parts, say, seven, the distance of any one part from A being the circumference corresponding to the radius at that part, as shown in Fig. 2. Perpendiculars are drawn from these points, terminating in the curve A E, and from the intersecting points hypotenuses are drawn to A. The angles formed by these hypotenuses with the base line are the pitch angles for the leading portion of the effective working face at the corresponding radii along the blade; that is, from 3, 4, 5, 6, and B on the leading edge F to Z—Figs. 2 and 3—and from the first part of the plan of construction. The second part is shown in Fig. 3.—*July 5th*, 1917.

GAS PRODUCERS.

107,561 (5160 of 1917). April 12th, 1917.—Blowing Apparatus for Producers, Axel Sahlin, The International Construction Company, Limited, 56, Kingsway, London, W.C. 2.

The producer A is provided with a central tuyere B composed of a series of concentric annular segments C forming apertures D E. The parts are secured together as shown. For the purpose of adjusting the lower or outer blast aperture E, the bottom casting F of the box is furnished with pockets G adapted to receive and hold nuts H for the bolts J passing through apertures provided in the casting F. The upper ends of the bolts J are arranged to bear on the under face of the lowermost segment. In operation, if it is desired to increase the blast through the lower aperture E, the bolts J are turned so as to raise the segment

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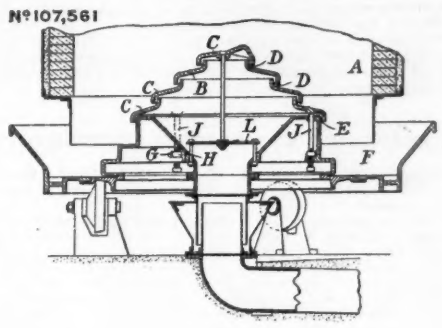

from its bearings, the segment being guided by ribs co-acting with the bottom casting F. As the segment rises, the aperture E is increased in width and therefore in area, and the spring L is deflected, the tension on the bolt being increased. To reduce the area and thereby the blast through the aperture E the reverse operation is necessary.—*July 5th*, 1917.

PUMPING AND BLOWING MACHINERY.

107,533 (18,596 of 1916). December 29th, 1916.—Centrifugal Pumps, Hans Eicheler, Wesseling, Rhenish Prussia, Germany.

The invention relates to improvements in centrifugal pumps, and particularly to means to relieve the stuffing-box of pressure. Behind the main wheel G is placed an auxiliary wheel A, and a relieving disc F connected to the auxiliary wheel. The stuffing-box B is placed at the rear of the auxiliary wheel A; C indicates a chamber in which the liquid circulates back into the auxiliary wheel. The pressure produced by the main wheel is present also in the chamber H between the wheel G and the part I of the casing. The hub K of the relieving disc F turns with

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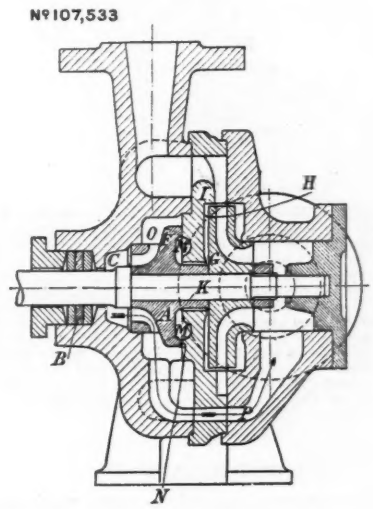


very little play in the portion I of the casing, so that the pressure of the liquid, reaching from H the chamber M, is throttled. Hence the pressure in M being reduced, the disc F is subject at its border almost to the full over-pressure, produced by the rotor G against the part I of the casing, so that at N a further strong throttling will take place, and the internal pressure is thereby almost completely compensated, the stuffing-box B being nearly completely relieved of thrust in consequence. When the pump is aspirating the liquid passing over into the chamber O is led off through the channel connected to the suction side of the pump, so that it does not reach the stuffing-box.—*July 5th*, 1917.

TRANSMISSION OF POWER.

107,422 (9104 of 1916). June 28th, 1916.—Clutch, Gogu Constantinesco, Haddon Engineering Works, Honeypot-lane, Alperton, Middlesex.

This is a clutch in which a spiral spring, between the driving and driven members, has the planes of its convolutions inclined

No 107,422

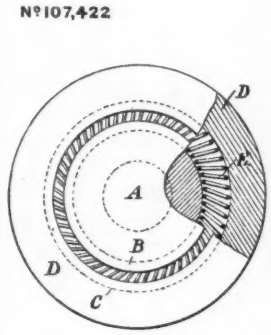


Fig. 1.

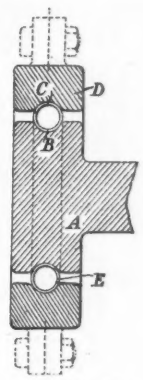


Fig. 2.

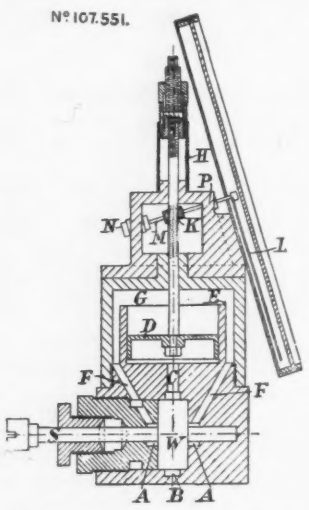
to the axis of the spiral. In the form shown in Figures 1 and 2, the driving member A is formed with a groove B and a corresponding groove C is formed in the driven sleeve D. In the space

between the grooves is inserted a spiral spring E, which is so formed before insertion that its convolutions will be at an angle to the axis of the spiral of less than a right angle, so that the planes of the successive convolutions pass on one side of the axis of rotation. In the example illustrated the drive will take place in a clockwise direction. When the member A is rotated in this direction friction will tend to turn the planes of the convolutions toward the radial position, causing the spring to bind between the driving and driven members, while when the member A is rotated in the opposite direction, or when the member D overruns, friction will tend to turn these planes away from radial position, allowing free relative movement between the parts A and D.—*June 28th*, 1917.

MEASURING AND TESTING INSTRUMENTS.

107,551 (3216 of 1917). March 5th, 1917.—Liquid Speedometer, William Alexander, 1, Broomhill-avenue, Whiteinch, Glasgow.

In this instrument S is a shaft rotated by the machine, the speed of which is required. A vortex wheel W, of the centrifugal type, is rigidly mounted on the shaft, and has passages formed in it for allowing fluid to pass from the inlet spaces A, round the shaft, to the outlet space B round the vortex wheel. The high pressure fluid is delivered up the outlet passage C to the under side of the spring-loaded piston D, and forces the piston upwards to an extent depending on the speed. The liquid is displaced from the upper side of the piston into the reservoir G and passes to the inlet of the vortex wheel by the passages F.

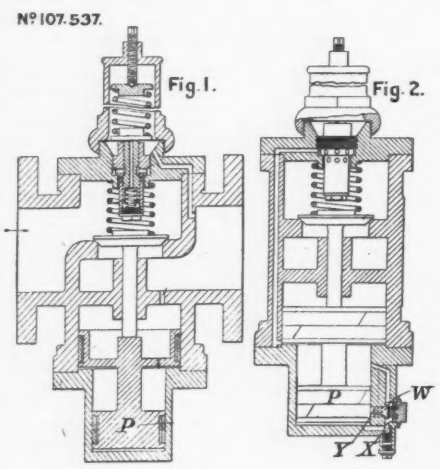


The liquid in the reservoir G covers the upper edge E of the cylinder and remains at a constant level in the reservoir. The free surface of the liquid in the reservoir remaining at constant height, the motion of the piston is not influenced by changes of levels of liquid and the graduations of the speed dial are rendered independent of the relative volumes or the shapes of the reservoir and other spaces occupied by liquid. The piston is connected to the spring H, and has a motion proportional to the difference in fluid pressure at A and B. The motion of the piston is communicated by means of the rack and pinion K to the dial pointer L, which moves over a scale calibrated to give the speed of the vortex wheel. The pinion and the dial pointer are both rigidly connected to the spindle M mounted in bearings N and P.—*July 5th*, 1917.

MISCELLANEOUS.

107,537 (835 of 1917). January 17th, 1917.—Pressure Regulators, James Francis Gill, 25, Castle-street, Liverpool, and another.

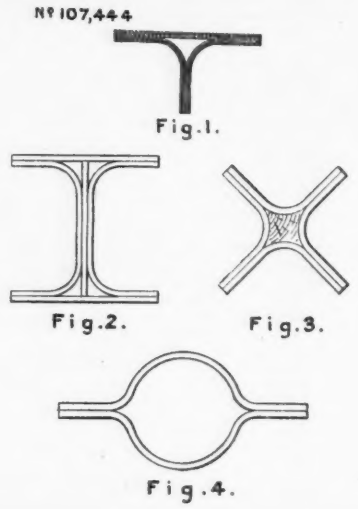
This invention is for an improved form of pressure regulator of the kind in which the opening of the main regulating valve is governed by the pressure which it is desired to control acting on one or more flexible diaphragms. Figs. 1 and 2 are sectional views of a regulator fitted with the improvement. In combination with the dash-pot P is provided a non-return valve W, so arranged that while the fluid contained in the dash-pot P can pass freely from the lower to the upper side of the piston the return flow can only take place past the regulatable needle valve X. It will be noticed that the port Y communicating with the



non-return valve W is not at the bottom of the cylinder, but in such a position that it is blanked off by the lower piston ring or bottom part of the piston before the main valve is quite on its seat. This permits of the main valve closing rapidly down to a certain point, then it can only seat itself slowly owing to the remainder of the fluid under the dash-pot piston having to pass the restricted opening of the needle valve X. In this way the inventors provide for the gradual opening of the main valve, but it is free to close rapidly until it is near its seat, and then it must close down finally in a gradual manner. This is to prevent any hammering of the seat.—*July 5th*, 1917.

107,444 (10,415 of 1916). July 24th, 1916.—Wooden Stays, Joists and Girders, Henry Rutherford, Little Haugh, Banstead, Surrey.

This invention consists essentially in the combination of two or more sheets of wood, preferably in the form of plywood, bent and secured together to form stays, joists, girders, and the like of X, T, H, O, or other section, the joists between the several sheets or boards being secured by any suitable adhesive material or by rivets or other metallic attachments, or both. In carrying out



the invention, according to the section of the stay or the like to be produced, two or more sheets of plywood of comparatively thin section are taken and bent to such shapes that when they are united they form the desired section, and present corresponding edges or surfaces to one another which can be united by a suitable adhesive or rivets. To facilitate the bending and manipulation of the sheets they may, if desired, be previously steamed or otherwise softened. Figs. 1–4 represent sections of various forms so constructed.—*July 5th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for The Engineer *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of five of the patents given below £26 and on each of the remainder £18 have been paid in renewal fees.

No. 21,794/10.—Bearings. A cage for ball or roller bearings, consisting of a perforated ring, is provided with projections which fit into the races between the balls or rollers. Should a ball or roller be broken, the fragments are carried round by the projections and prevented from obstructing the adjoining balls or rollers. Krupp Akt.-Ges., F., Germany. Dated November 25th, 1909.

No. 21,796/10.—Ordnance; breech mechanism. Relates to the class of wedge breech mechanism operated by a lever which is pivoted to the gun, and which has a roller on one arm engaging a cam-groove in the block. Krupp Akt.-Ges., F., Germany. Dated April 9th, 1910.

No. 21,898/10.—Type bar making machines; assembling and distributing matrices. In composing from multiple-face matrices—or dies—the usual setting switch in the assembler and the retractable slide in the first elevator are dispensed with, the selection of face, when composing entire lines in the same face, being effected by adjusting the levels of the organs concerned in the transference of the matrices. Mergenthaler Setzmaschinen-Fabrik Ges., Berlin. Dated November 9th, 1909.

No. 22,204/10.—Treating electrolytic iron. In making sheets, bands, wires, laminæ for dynamo armatures, &c., from electrolytic iron, the iron is deposited on a thin electrolytic iron sheet as cathode to a thickness greater than the desired product, and is then rolled or drawn and thereafter annealed. By reversing or stopping the current during deposition, the plates, &c., may be deposited in layers, which may be separated after the rolling operation. Langbein-Pfanhauser-Werke Akt.-Ges., Leipzig. Dated September 28th, 1909.

No. 22,225/10.—Coke ovens. Relates to regenerative coke ovens having vertical heating flues arranged in groups, and continuously traversed by flames and having also a longitudinally divided oven sole flue. Wagener, E., Germany.

No. 22,433/10.—Purifying gases. In apparatus for purifying gases consisting of a series of perforated co-axial cylinders or cones rotating in opposite directions, washing water is supplied at the centre of the machine. Theisen, H. E., Germany.

No. 22,519/10.—Moulding; concretes. In the manufacture of tubular concrete sections for building chimneys, particles of hard-burned bricks and chamotte, about 3 mm. or 4 mm. in diameter, are added to the cement or concrete. Suitable moulds are filled with this mixture, which is moistened, and the moulds are shaken vertically in order to make the mixture homogeneous. Schofer, F., Germany. Dated May 23rd, 1910.

No. 22,766/10.—Ammunition; projectile fuses. Consists in throwing the safety device of percussion fuses out of action by a spring clockwork which is started when the gun is discharged. This arrangement is especially suitable for combined percussion and mechanical time fuses. Krupp Akt.-Ges., F., Germany. Dated November 18th, 1909.

No. 22,976/10.—Type-bar making machines. In means for supporting two-letter matrices before the mould, all the matrices, whatever their level, are supported at the same part of the matrix, which part is such that it cannot be damaged during assembly. Degener, H., Berlin. Dated October 6th, 1909.

No. 23,121/10.—Electric incandescent lamps; filaments; filaments, supports for. Filament wire to be passed continuously over a series of supports is strung on a former and given kinks at the points that are subsequently to engage the supports, enabling very thin supports to be used, such as thin helical wires with hooked ends. The filament may be drawn refractory metal, or a ductile alloy or mixture with vaporisable material, and it may be crimped. Schroter, K., Berlin. Dated January 19th, 1910.

No. 23,145/10.—Explosives. Relates to nitroglycerine-nitrocellulose explosives containing less than 30 per cent. of nitroglycerine, and manufactured at high temperatures and under high pressures. According to this invention, nitroglycerine and nitrocellulose are mixed, without either volatile or non-volatile solvents, at a temperature of about 90 deg. Cent., and a pressure of about 200 atmospheres, and the gelatine thus obtained is moulded into tubes without any drying process. Claessen, C., Berlin.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W.

ORDERS

For the week, by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Platoon Commander P. Bowden.

Next for Duty.—Platoon Commander W. J. A. Watkins.

Monday, August 13th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street, Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, August 14th.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, August 15th.—Drill and Elementary Bridge Construction, No. 1 Company, Right Half Company.

Thursday, August 16th.—Drill and Elementary Bridge Construction, No. 2 Company, Right Half Company. Ambulance Class.

Friday, August 17th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the Capitation grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at headquarters, and every enrolled man must obtain one without delay, and all old—red—armlets must be returned to the Orderly Room.

Note.—Unless otherwise indicated, all drills will take place at headquarters.

By order,

August 11th, 1917. Macleod Yearsley, Adjutant.

CATALOGUES.

The Cummings Ship Instrument Works, Boston, Mass.—Illustrated descriptive pamphlet dealing with the Gary Cummings Torsion Meter.

Tuck and Blakemore, Limited, Coventry.—Illustrated catalogue of "Godiva" tools, including scroll chucks, drill chucks, drills, sockets, reamers, milling cutters, hand and machine chasers, tool holders, lathe dogs, metal saws, pipe vices and wrenches, ratchet braces, pipe cutters, files, vices, taps and dies, grinders and grinding wheels, wheel dressers, corundum stones, wrenches, verniers, hack saws and blades, metal shearing machines, &c.

"Hints on Rectifying Faults in Motor Control Gear" is the title of a booklet which has been issued by Mr. George Ellison, of Wellhead-lane, Perry Barr, Birmingham. It is a thoroughly practical little treatise, which has been prepared with the object of helping electricians in charge of motors and control gear to combat the troubles which arise in working, and which, although frequently trivial in themselves, are the cause of stoppage and delay. The subject has been dealt with in a general way, and the advice given in various cases of difficulty appears to be eminently practical.

British Reinforced Concrete Engineering Company, Limited, 1, Dickinson-street, Manchester.—A pamphlet has been sent us by the above firm entitled "Floor Slab Reinforcement." In an article on the subject Mr. H. C. James-Carrington, M.I. Mech. E., states that he has used B.R.C. fabric for slab reinforcements for various purposes during the last ten years with gratifying results. The work carried out includes a foundation raft, flat roof, brass foundry floor, engineers' machine gallery floor, and flooring for warehouses. The pamphlet states that all B.R.C. fabric is made from drawn steel wire having a breaking strength of about 40 tons per square inch, and an elastic limit of about 75,000 lb. per square inch.

Turner Brothers Asbestos Company, Limited, Rochdale,—Insulating materials form the subject of this publication. The contents include particulars of "Firefelt" asbestos coverings for steam boilers and piping, removable flange and valve covers, asbestos fibre rope, and asbestos mattresses. As a non-conducting covering for locomotive and marine boilers, cylinders, &c., the mattresses are specially designed for application where frequent examinations are necessary. These mattresses are made of strong asbestos cloth, filled with finely carded asbestos fibre to the required thickness, and sewn firmly together to prevent shifting of the fibre owing to vibration. They are shaped to suit all fittings with which they come in contact, and when required can be secured with iron bands, or by any other suitable method which will not prevent their expeditious and easy removal when necessary.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Controller of Coal Mines has appointed Mr. Frank Pick, Commercial Manager of the London Electric Railways, as his assistant to deal with matters in connection with the London Coal Distribution Scheme.

Mr. Thomas W. Cherry has been appointed to the position of sole representative for Cammell, Laird and Co., Limited, Sheffield, in the North-East Coast district, which position was previously held by the late Mr. Joseph Johnson for many years. The firm's offices are at 32, Grainger-street West, Newcastle-upon-Tyne.

The Consolidated Pneumatic Tool Company, Limited, asks us to state that the Government authorities having commandeered its offices at Palace Chambers, it has been obliged to secure temporary accommodation at Egyptian House, 170, Piccadilly, W. 1, to which address all communications should be sent, until further notice. The telegraphic address will be "Caulking, Piccy, London." There will be no alteration to the present telephone number, viz., Gerrard 9215—three lines.

Engineering Library
SEP 14 1917
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The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2

VOL. CXXIV.—No. 3216] LONDON: FRIDAY EVENING, AUGUST 17, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

STEAM ROLLERS WANTED.

Second-hand Steam Rollers, of standard sizes, are REQUIRED for Government purposes.—Offers (in envelopes marked "Steam Rollers," and giving full particulars as to make, type, date of purchase, present condition, &c., and where the rollers offered can be inspected) should be addressed:

THE DIRECTOR-GENERAL OF MUNITIONS CONTRACTS (P.M. 4),
28, Northumberland-avenue,
453 London, W.C. 2.

War Department.—
ORDNANCE DEPOTS, AERODROMES, AND MILITARY CAMPS.

POSITIONS NOW VACANT.—Station Engineers, Mains Engineers, Shift Engineers, Engine Drivers, Fitters, Fitter-Drivers, conversant with three-phase steam, or D.C. internal combustion engine systems. Also Linesman-Jointers, Wiremen, Wiremen's Mates and Stokers.

Applications, enclosing copies only of testimonials, and stating briefly training, experience, age and wages required, should be sent to the undersigned at once.

Envelopes to be endorsed "Electrical Staff."

Any applicants of military age must state their classification.

CHIEF ENGINEER,
Southern Command.
12, Wilton-road,
Salisbury. 436 A

UNIVERSITY OF DURHAM.

Armstrong College, Newcastle-
UPON-TYNE.

PRINCIPAL: W. H. HADOW, M.A., D. MUS., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—

F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic
INSTITUTE,
St. John-street, London E.C.

ENGINEERING DAY COLLEGE.

Full Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering will commence on Monday, 1st October, 1917. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and Aeronautical Engineering, and those in Electrical Engineering include specialisation in Radio-Telegraphy.

ENTRANCE EXAMINATION on Tuesday and Wednesday, 25th and 26th September, 1917. These courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees, £15 or £11 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £52 each will be offered for competition at the Entrance Examination in September, 1917.

TECHNICAL OPTICS.

Full and Part-time Courses in this important department of Applied Science will be given in specially equipped laboratories and lecture-rooms. An AITCHISON SCHOLARSHIP (value £50) will be offered in this department at the Entrance Examination.

Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute, or on application to

R. MULLINEUX WALMSLEY, D.Sc.,
423 Principal.

South-Western Polytechnic In-
STITUTE, CHELSEA, S.W. 3.

UNIVERSITY AND TECHNICAL DAY AND EVENING COURSES IN

MECHANICAL AND ELECTRICAL ENGINEERING.

Commence 24th September.

SCHOLARSHIPS EXAMINATION, 17th September, 10 a.m.

Apprenticeship scheme for Engineers.—Prospectus on application to SECRETARY (Room 22). Telephone: 899 Western. 439

University of Manchester.

FACULTY OF SCIENCE.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Full particulars of the Courses will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on the 4TH OCTOBER. 319

Ashton-under-Lyne, Stalybridge
AND DUKINFIELD (DISTRICT) WATERWORKS

The Joint Committee REQUIRE the SERVICES of a thoroughly capable and energetic ENGINEER to take the entire charge and management of the Out-door Department of their Undertaking.

The area of supply is about 33,470 acres, and includes four Municipal Boroughs and two Urban District Councils within their Contributory district, and several adjoining Urban Council Districts within their non-contributory district, the population of the whole being about 140,000.

There are twelve impounding and service reservoirs situate in different districts having total capacities of nearly 1090 million gallons.

Applicants must have had considerable experience in the preparation of plans, estimates and reports of work required, superintending the laying of mains and services and control of men, together with experience of the latest systems of mechanical pressure filters.

Applications, stating age, salary, experience, &c., and enclosing copies of three recent testimonials, to be sent to the undersigned not later than the 5th day of September, 1917, endorsed "Engineer." Canvassing prohibited.

LEES BUCKLEY,
Secretary.

Waterworks Department,
Town Hall Chambers,
Ashton-under-Lyne.
10th August, 1917. 429 A

PATENTS AND DESIGNS ACTS, 1907-1914.

FLEXIBLE COUPLINGS.

The Proprietors of British Letters Patent No. 17,174 of 1912 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to a flexible coupling built up of strips or bands of textile material or thin metal.

Address, BOULT, WADE and TENNANT,
111 and 112, Hatton-garden,
471 London, E.C. 1.

Wanted, by Paris Firm, English- SPEAKING MINING ENGINEER especially conversant with Business and Administration; willing to go occasionally to N. America. Mention qualifications and salary required.—Reply, in first instance, to 450, "The Engineer" Office. 450 A

Wanted, Foundry Manager for large Engineering Works in Midlands, thoroughly experienced green, dry sand and loam. State age, experience and salary required. No one on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3500. 330 A

White Oil Plant.—Consulting ENGINEERS with requisite experience REQUIRED.—Write to Box No. 66, c.o. Dawson's, 121, Cannon-street, E.C. 4. 440 A

Works Manager for Controlled Establishment in Scotland employing 400 hands on General Work. Liberal encouragement offered to a thoroughly able man who is a good organiser and a regular hustler.—Address, stating age, experience, and salary expected, to 462, "The Engineer" Office. 462 A

Engineer's Buyer Wanted. Pre- FERENCE given to one having experience in Locomotive and Light Railway Work, also Estimating (he would be required to deal with all shop orders and material). Only competent, experienced men need apply, and no person already on Government work will be engaged.—State experience, age, and salary required to your nearest Employment Exchange, quoting "The Engineer" and number 468. 468 A

Engineers with Practical Experi- ENCE of Design of Ferro-Concrete Structures REQUIRED by MOUCHEL and PARTNERS, Ltd., 38, Victoria-street, Westminster, S.W. 1.—Apply by letter, stating age, experience and salary required. P864 A

First-class Experienced Esti- MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Manager Required for Drop Forging Plant. Must be thoroughly conversant with the latest practices in Drop Forging and Die Sinking. Capable of supervising extensions in plant, which will comprise Stamps ranging from 5 tons to 10 cwts. Commencing salary £800 per annum and bonus. No person employed on Government work need apply.—Write, giving full particulars, to 443, "The Engineer" Office. 443 A

Piece Work.—Wanted, First-rate ENGINEER of wide experience in this work to introduce and have entire charge of system in large works employing over 3000 hands, engaged in repetition munition work. No one already employed on Government work can be engaged without the consent of their present employers. Write, giving salary required, &c., to 467, "The Engineer" Office. 467 A

Research Physicist Wanted for large Scientific Instrument Factory. Graduate in Science, with workshop experience preferred.—Reply, stating age, salary, and full details of experience, to 480, "The Engineer" Office. 480 A

Chemist.—Youth Required, of good education, as ASSISTANT CHEMIST. One with some experience of Steel Analysis preferred. Good opportunity in well-equipped laboratory. Must be ineligible for military service. No person already on Government work will be engaged.—State age, experience, and salary required to your nearest Employment Exchange, quoting "The Engineer" and No. A3411. 458 A

Chief Cost Clerk Required for Electrical Engineering Works in S.E. London. No person already on Government work will be engaged.—Apply, stating age, full particulars of experience, and salary required, to your nearest Employment Exchange, quoting "The Engineer" and number 477. 477 A

Clerk, with Experience, to Assist in Purchasing Dept. of Engineering Firm in Midlands, age about 25 years. No man already on Government work will be engaged.—Application, in first instance, should be made to your nearest Employment Exchange, stating experience and salary required, and mentioning "The Engineer" and No. A3523. 392 A

Wanted, a Capable Draughts- MAN, with good knowledge of Steelwork and General Building Construction. He must be ineligible for military service.—Write, stating age, experience, forwarding copies of recent testimonials, to Box No. 832, c.o. Street's, 8, Serle-street, London, W.C. 473 A

Wanted for the Electrical Engi- NEER'S Dept. of a large Steel and Iron Co. in the North Midlands, several good DRAUGHTSMEN who have had experience in the design of S.H.T. and H.T. Substations, and the layout and installation of motors, cables, switchgear, and special appliances in connection with the driving of heavy Steel Works or other similar plant engaged on varied classes of War work. Applicants are requested to give their age, and submit references and details of their training and experience, also to state the wages required, and the earliest date upon which they could take up their duties if selected for the post. No person already employed on Government work will be engaged.—Apply, nearest Employment Exchange, mentioning "The Engineer" and number 463. 463 A

Draughtsman, Junior, Mechan- ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234. 12 A

Draughtsman (Mechanical or Electrical) REQUIRED in London (West) by a firm of engineers engaged on Admiralty work. No one living more than ten miles away or already employed on Government work will be engaged. State age, experience and salary required.—Address, 4 "The Engineer" Office. 435 A

Draughtsman, Mechanical, One used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 A

Draughtsman, Mechanical, Re- QUIRED at once, West London, for work on Government Contracts, preferably one having had experience in heavy Motor Vehicles. State age, experience, and salary expected. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number P900. P900 A

Draughtsmen Wanted, Tho- ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 A

Draughtsmen.—One Leading Man and One or Two Juniors WANTED for London office. Must have had first-class experience in Machine Tool or Forging Machinery work. Permanencies and excellent prospects for thoroughly capable men. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 397. 397 A

Several Senior and Junior MECHANICAL DRAUGHTSMEN for London REQUIRED, with general experience, for Detail Work. Good salaries to suitable men. No one already on Government work need apply.—Reply, stating age, experience, and salary required, to your nearest Employment Exchange, mentioning "The Engineer" and number 459. 459 A

Two Good Draughtsmen with experience in Rolling Mill work REQUIRED for a large London Drawing-office. No man already on Government work will be engaged.—Apply, giving experience, age and salary desired to your nearest Employment Exchange, mentioning "The Engineer" and number 445. 446 A

Wanted, for an Important Hydraulic Pumping Installation in South Wales, competent CHARGEMAN ENGINEER. Only men who have had experience of a similar capacity in a first-class station need apply. Must be ineligible for military service.—Address, stating age, qualifications, past experience and salary required, to 428, "The Engineer" Office. 428 A

First-class Machine Shop Fore- MAN REQUIRED for Aviation Works. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 447. 447 A

Fitter's Charge Hand, Over Mili- TARY age, for Works Repair Shop. (Usual restrictive conditions as to employment.) Copies of testimonials, references, and wages required, to F., Box 656, c.o. Judd's, 97, Gresham-street, E.C. 2. 470 A

Foreman Electrician Wanted by Engineering Works; must be used to high-tension wiring of all voltages and upkeep of plant, both alternating current and direct current. No person already on Government work will be engaged.—Apply, with references, to your nearest Employment Exchange, and mention "The Engineer" and No. A3542. 402 A

Foreman (Working) Wanted for a small General Engineer's Shop about 10 miles out of London, G.W.R. Must be thoroughly practical; a knowledge of foundry work an advantage. Ineligible, or, if on Government work, application only considered by consent of present employer. Send full particulars, age, &c., and state wages expected. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 482. 482 A

Wanted, an Improver for Turn- ING Rolls for light Rail Mill.—Address, stating rate of wages required and when at liberty, to 445, "The Engineer" Office. 445 A

Wanted, Two Leading Stokers to take charge of 8-hour shifts in large Generating Station in Midlands. Applicants must be experienced in the economical management of, and capable of doing minor repairs to, Underfeed E. type and A. type Stokers.—Address, stating wages required per week of 56 hours, to 425, "The Engineer" Office. No man at present engaged on Government work need apply. 425 A

Wanted, a Post of Responsi- BILITY by a practical and theoretical engineer, capable of organising and taking charge on marine, general engineering, or war work. Three years' experience in charge of general engineering and war work (manufacture of various classes of shells and gun parts), with control of female labour.—Address, 437, "The Engineer" Office. 437 B

Advertiser (25), C 3, and Re- QUIRED to do work of national importance, DESIRES ENGAGEMENT. Engineering Student at Birmingham University for two years; Public School education.—Address, P895, "The Engineer" Office. P895 B

Bridge and Constructional Engi- NEER-MANAGER OPEN for ENGAGEMENT. Age 40. Direct experience and thorough knowledge of all departments. Commercial and Drawing-offices, works, erections, estimates, &c. Capable and energetic handler of men and staffs. Could take financial interest after mutual trial. Replies treated in strictest confidence.—Address, P905, "The Engineer" Office. P905 B

Wanted,

BY THE

HEATLY-GRESHAM ENGINEERING CO., Ld.,

LETCHWORTH, HERTS,

ORDERS FOR

IRON CASTINGS

from 28 lb. up to One Ton. 460 I

An Engineer with Large Experi- ENCE in pumps, direct acting and semi-rotary, condensers, &c., at LIBERTY.—Address, P904, "The Engineer" Office. P904 B

Constructional Engineer and MANAGER, shortly to be disengaged, SEEKS APPOINTMENT; 10 years' experience on public works contracts; all branches of constructional works; used to dealing with large numbers of men and all kinds of contractor's machinery. Now employed constructing railways at one of H.M. munition factories (contract shortly terminating).—Address, 299, "The Engineer" Office. 299 B

Elect. and Mech. Engineer, University diploma, seven years' practical workshop and three years' drawing-office experience, DESIRES OUTSIDE POSITION.—Address, M. G., 54, Ravensbury-road, Wimbledon Park, S.W. 18. P897 B

Engineer, as Manager or Chief Draughtsman. Speciality, Air Heating and Drying. OPEN to ENGAGEMENT.—Address, P903, "The Engineer" Office. P903 B

Engineer, Experienced in the survey, design, construction, and erection of aerial ropeways, DESIRES ENGAGEMENT.—Address, P893, "The Engineer" Office. P893 B

Engineer, M.I. Mech. E. (44), 23 years' practical and commercial experience (14 years management), DESIRES CHANGE as GENERAL or WORKS MANAGER or other responsible position. Comprehensive experience. Speciality—mechanical transport. Up-to-date man, with practical knowledge all departments, scientific works organisation, production efficiency, and mass production of high-class repetition work. Accustomed to conducting negotiations at home and abroad. Highest references. At liberty short notice.—Address, in confidence, P834, "The Engineer" Office. P834 B

Engineer, Mech. (43), 27 Years' thorough practical, technical, works management experience in general engineering, REQUIRES RESPONSIBLE WORK. Commencing salary £300.—Address, W., 493, Chatsworth-road, Chesterfield. P899 B

Engineer (41), with Exceptional experience in the design and manufacture of AGRICULTURAL TRACTORS and COMMERCIAL VEHICLES, steam, petrol and paraffin, DESIRES responsible POSITION on War Work. Many years with leading firms, accustomed to handling men. Highest references.—Address, 401, "The Engineer" Office. 401 B

Steam, Hot Water, &c.—Engi- NEER DESIRES APPOINTMENT. Engagement in Scotland, war work, unexpectedly terminated; satisfactory reasons. Previously manager heating Department leading London firm; mechanical training; wide general experience; management; direction of labour; representation. Highest references. 46. Glasgow district preferred, but open offer elsewhere.—No. 247, A. F. Sharp and Co., Advertising Agents, Glasgow. P901 B

Works Manager. — Engineer, with wide experience in production, small machines tools, jigs, fixes, primers, screws, &c., is OPEN for ENGAGEMENT.—Address, P902, "The Engineer" Office. P902 B

Machine Shop Foreman or SUPERINTENDENT at LIBERTY; organiser; modern methods; good tool designer.—Address, P886, "The Engineer" Office. P886 B

Steel Works Chemist, Thoroughly experienced in all branches of metallurgical analyses, &c., DESIRES CHANGE; capable of taking charge of any sized iron, steel, or engineering works laboratory.—Address, P894, "The Engineer" Office. P894 B

A Large Firm of Engineers in the Midlands HAVE an OPENING for a YOUTH of Good Education as PREMIUM PUPIL, the course to include both Works and Drawing-office. Address, 2002, "The Engineer" Office 2002 B

Inst. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G.P. KNOWLES, B.Sc., A.M.Inst.C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Hundreds of successes during the past twelve years. Courses can be commenced at any time.—38, Victoria-street, Westminster, S.W. 238 B

Agency.—A Firm of Mechanical Engineers, having a very extensive and well established connection with Steam and Power Users generally, are OPEN to REPRESENT one or two first-class Manufacturers in London and the South of England.—Write, 448, "The Engineer" Office. 448 D

London Representation.—Adver- TISERS have had 15 years' experience in Railway Rolling Stock Supplies and Plant for Colonial and Foreign Railways. Acquainted with the leading consulting engineers' requirements. AGENCIES for Specialities of particular interest to railways and the export trade generally WANTED either immediately or later on.—Address in confidence, 7, "The Engineer" Office. 7 D

United States.—City Merchant leaving shortly for New York is OPEN for BUYING COMMISSIONS in the Allied Steel Trades, Motor Cars, and Accessories, &c. Can finance all shipments.—Address, 469, "The Engineer" Office. 469 D

Managing Partner Wanted, in place of Partner wishing to take less active part, in Engineering and Ironfounding Business in West Riding Town.—Address, for particulars, 420, "The Engineer" Office. 420 C

PARTNERS
DIRECTORS
BUSINESSES
FACTORIES
for these apply to
WHEATLEY KIRK, PRICE AND CO.,
46, Watling-street, LONDON, E.C.
Albert-square, Manchester.
25, Collingwood-street, Newcastle-on-Tyne. Sp 3005

SMALL ADVERTISEMENTS
SITUATIONS, FOR SALE, &c.,
PAGES II., III., LXXXII.

Numerical Index to Advertisements.
PAGE LXXXI.

Wanted at Once, New or Second- HAND BORING, TURNING, and SURFACING LATHE, suitable for Fly-wheels. To admit 7ft. dia. by 24 wide, and to bore 15in. dia. (not Screw Cutting). If second-hand must be in first-class order. Full particulars, giving weight, maker's name, and age of lathe, and photo to Messrs. SMITH and GRACE, Ltd., Thrapston. 472 r

Wanted at Once, 5 or 6 Furrow PLOUGH for double engine system. Must be in good order.—Particulars to DYKES BROS., Ltd., Cardington, Beds. 432 r

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THE REVIVAL OF THE MONITOR.

Not the least remarkable feature of the great war is the reappearance of many weapons which had long been discarded as obsolete. To find a parallel to the methods of fighting which are now general along the continental battle-fronts we must go back to ancient history. Asphyxiating gas takes us back to the Chinese stink-pot, the "Flammenwerfer" to Greek fire, the trench dagger to the still remoter periods when man first discovered the lethal potentialities of cold iron, while certain forms of the trench mortar, which has become so indispensable in this war, are simply an adaptation of the ancient catapult. The list, which could be extended almost indefinitely, includes many weapons used in the naval campaign. A few years ago the monitor was regarded as a thoroughly obsolete type of ship, the construction of which had altogether ceased. Yet to-day we find vessels of the monitor class taking an active part in naval operations in almost every part of the globe. It may therefore be of interest to trace the development of this type from its advent down to the monitors of the present day, though for obvious reasons little can be said about the most modern examples.

Ericsson's Monitor,* built in 1861, was not a hasty project conceived under stress of a grave emergency. About eight years previously the inventor had submitted to the Emperor Napoleon a design which embodied all the characteristic features of the ship that subsequently proved a match for the Merrimac. He described the plans as those of "an invulnerable ship which could destroy with ease and impunity to itself the largest ironclad frigates now afloat." The French Emperor, however, was not sufficiently impressed to take any steps in the matter, and it was not until October, 1861, that the keel of the first monitor was laid at New York. She was launched three months later and delivered, ready for sea, on February 15th, 1862, only 118 days from her commencement. The dimensions were: extreme length 172ft., breadth 41½ft., draught 10½ft., displacement 1000 tons. In almost every respect her constructional features differed fundamentally from the practice of that day, and it is not surprising to learn that the Federal naval officers were utterly sceptical as to her value for practical purposes. But Ericsson's faith in his own genius rendered him adamant to criticism and expostulation. In the course of the building and during the trials certain minor defects, mainly due to carelessness on the part of subordinates, revealed themselves, and the Navy Department desired to replace faulty fittings by others of standard pattern. Ericsson would not hear of it. He made good all the deficiencies in a few days, and when the vessel finally hoisted the flag he had the satisfaction of knowing that she was in every respect his own creation. "The Monitor is *mine*," he said, "and no change shall be made." And as Mr. H. W. Wilson observes: "He had designed the ship and all its parts—hull, turret, gun-carriages, engines, and anchor-hoisting machinery, and put into it no less than forty patentable contrivances. No wonder he called it his." How the Monitor, after a stormy passage from New York, in which she nearly became waterlogged through the sea pouring down her leaky hatches, arrived at Hampton Roads just in time to prevent the destruction of the Union squadron by the Merrimac, and how the two ships fought an epoch-making duel, is a story too well known to be repeated here.

The influence of this engagement on naval construction was hardly less far-reaching than that which the Dreadnought all-big-gun ship exercised forty-three years later. Almost every Power began to build monitors, though for a long time designers laboured under the mistaken idea that the principle was applicable to sea-going ships, whereas in reality Ericsson had never intended the prototype to be anything but a coast-service vessel. From 1000 tons the displacement rose rapidly, until, in the Roanoke—a wooden frigate converted into a low freeboard monitor—it reached 6300 tons. This, however, was high-water mark, for most of the monitors built in the United States and abroad did not exceed 4000 tons. Notable American exceptions were the Colossus, Massachusetts, and Oregon, each 322ft. long, and 6000 tons in displacement. Designed to draw 17ft. of water, they were propelled by twin screws, and were expected to prove thoroughly seaworthy ships. The Dictator and Puritan were later developments of this attempt to evolve a sea-going ship, possessing all the offensive and defensive qualities of the monitor. They were, in fact, the first mastless ironclads, but their behaviour at sea was not such as to encourage perseverance along this line of development, and it was soon recognised that although the monitor was an admirable type for coast service, it was not destined to supersede the battleship for work on the high seas. Nevertheless, that it could on occasion successfully negotiate the open sea was shown by the Transatlantic voyage of the Miantonomoh. This vessel was 250ft. long and 55ft. broad, her displacement at load draught being about 3900 tons. She was plated with 7in. armour on the sides and had two turrets. Her engines were not good for more than nine knots, at which rate of steaming she consumed 40 tons of coal per day. She made the passage from St. John's, Newfoundland, to Queenstown in 10 days 18 hours, and according to a narrative of the voyage,† seas were encountered in which an ordinary frigate would have been unable to open her ports, "while in the case of the Miantonomoh, although the deck was covered with water to a depth of 4ft. with the wind ahead, the sea was so broken by the turret that it was possible to fire in a line with the keel. In a seaway, whether going ahead or with the engines stopped, it was always possible to fire to leeward, and the rolling was described as very moderate. With a following sea the waves were divided in the same manner as when a head sea was encountered, but to windward the ports were constantly submerged. The captain reported that instead of behaving as an ordinary vessel the monitor allows the water to flow freely over the deck—thus imposing a heavy weight on the weather side and causing the vessel to roll to windward. As the sea had to ascend an inclined deck, the greater part of the water rolled off on the weather side." This voyage was considered a most daring and remarkable performance, but it has been far surpassed by that of the two small British monitors, Severn and Mersey, from England to East Africa in the spring of 1915, for these little vessels were less than one-third the tonnage of the Miantonomoh, and had been designed only for river service in South America. The story of their adventurous journey should make entrancing reading when the authorities see fit to publish it.

The armament of the original Monitor consisted of two 11in. smooth-bore guns, firing projectiles of 135 and 166 lb. Some of the later ships carried a pair of 15in. smooth bores, using 440 lb. shot and 352 lb. shell. Against fairly stout armour these weapons made no impression, but the only rifled guns then available in the States had a habit of bursting, and were therefore not often supplied to the monitors, since the effect of such an accident in the confined space of a turret would have been particularly deadly.

Among the European Powers, Russia was foremost in providing herself with a fleet of monitors. In 1864 she launched no less than twelve such vessels, the displacement averaging 1500 tons. Originally armed with muzzle-loaders, at a later date they were fitted with 9in. Obuchoff breech-loading rifles. Further monitors were built, until by the early seventies nearly a score had been completed for the Russian Navy. "This stupendous fleet of ironclads," as a *Times* correspondent somewhat euphemistically styled it, made a great impression in England, but the truth is that these vessels added little to Russia's sea power, and could never have been employed with safety or effect outside the Baltic. The freeboard of all was very low, the speed of the best did not exceed eight knots, and the vessels themselves were so badly constructed that a short voyage in heavy weather, or even the discharge of their own guns, was generally enough to send them into the dockyard for many months.

In this country the monitor in its original form was never adopted. It was looked upon as essentially a type for coastal navies, as distinct from those which, like the British, were meant to keep the sea at all seasons and in all weathers. Still, in 1879 *The Times* declared that "the American monitors . . . . were certainly the progenitors of our 'Devastation' type." It was not until the outbreak of the present war that we discovered the value of shallow-draught vessels, carrying a few powerful guns, for those inshore operations which have become so familiar a phase of the naval campaign during the last three years. A very successful early example of the type was the Rolf Krake, constructed for the Danish Government in 1860 to the plans of Captain Cowper Coles. Her dimensions were:—Length, 185ft. 2in.; beam, 38ft. 3in.; draught, 9ft. 2in.; displacement, 1325 tons. The engines were of 750 horse-power, realising a speed on trial of 7.8 knots. Iron armour-plate 4½in. thick protected her sides from the upper deck to 3ft. below water. The two turrets each contained a pair of 68-pdr. Armstrong guns. In the war of 1864 this little vessel was repeatedly engaged with the Prussian ships and shore batteries, and did great execution against both at small cost to herself. The following extract from the diary of a Prussian artillery officer who was present at the battle of Alsen is of interest:—"The Danes certainly have one trump in their hands, and that is the ironclad Rolf Krake. All to-day we have been pounding at her and she at us, but whereas we have to deplore the loss of three field guns and many men, our opponent's injuries seem to be limited to a few dents in her armour. We fired over 300 rounds of 24-pounder shot and shell at this ugly sea monster, but for all the visible effect we might have been pelting a crocodile with pebbles. And she in return kept sending us her great shells, which explode like thunderbolts, and rake our battery with hurtling fragments of iron." Moltke, in his "Letters," also alludes to the Rolf Krake as that "thick-skinned fellow," against whose ribs the Prussians' 12 and 24-pounder shots rattled loudly but harmlessly.

From 1870 onward the construction of monitors was discontinued in practically every country save America, and even there most of the progress in this direction was limited to the rebuilding of old monitors and the completion of others whose construction had been retarded by lack of funds. The Miantonomoh furnished a notable instance of this last-named policy, and in her renovated state she remained on the active list of the United States Navy down to a very recent date. Other ships which had been lying on the stocks for years, and were finally completed in a form very different from that of the first design, were the Amphitrite, Monadnock, Terror, and Puritan, of which the first two are still on the active list. The cost of completing them averaged about £200,000 per ship, which, in view of their indifferent fighting value under the conditions that prevailed when they finally entered into commission, was undeniably excessive. For coast defence service, however, they were formidable ships by virtue of their thick armour and powerful breech-loading guns. Several of them took an active part in the Spanish-American war, in which they were used chiefly for bombarding shore defences. The Navy Department at first made the mistake of attaching them to battleship and cruiser squadrons, in which capacity their low speed and poor sea qualities made them more of a hindrance than a help. In view of the fact that naval strategists had unanimously condemned the monitor as obsolete, some surprise was occasioned when, in 1898, the American naval programme of that year made provision for four coast-defence ships of the monitor class. Considerations of a political rather than a strategical nature appear to have prompted this measure, for the record of the monitors in the Spanish war had not been such as to justify their perpetuation in modern form. The cost of the new ships, built as the Arkansas, Florida, Nevada, and Wyoming—subsequently re-named Ozark, Tallahassee, Tonopah, and Cheyenne respectively—was limited to £250,000 each for hull and machinery, and as this made very moderate dimensions essential it was found impossible to provide for more than two heavy guns per ship. In explaining the plans, Lieut.-Commander Beehler, U.S.N., stated that, compared with the older monitors, such as the Amphitrite and Monadnock, "the present design, owing to saving of weight in hull and machinery, is superior in speed, in protection, and in every other particular excepting gun power, which is, considered as a whole, only slightly less than in the case of the vessels mentioned, which have four 10in. guns mounted in two turrets. . . . The special features of the latest monitor design involve the use of water-tube boilers entirely, the adoption of the most recent designs of balanced turret, high-power 12in. guns, and the extended application of electricity for turning gear, hoists, ventilating blowers, &c. In the general arrangements many improvements have been introduced, which it is believed will add to the comfort of officers and crew, and to the efficiency of the vessel. The stern has been rounded so as fully to protect the screws, increasing the deck room at the same time. The state rooms for all officers, including the captain, are situated on the berth deck. The mess-room for the ward-room officers is arranged in the after end of the superstructure." The following are the dimensions of this class:—

Length on load water-line	252ft.
Length over all	255¼ft.
Breadth, moulded	49ft. 10in.
Breadth, extreme	50ft.
Freeboard (uniform)	2ft. 6¾in.
Mean draught (400 tons coal and all stores)	12ft. 6in.
Displacement (at full load draught)	3356 tons.
Indicated horse-power	1712
Speed	12 knots.

The main armament comprises two 12in. 40-calibre guns, mounted in one turret, while four 4in. and some smaller guns are distributed about the superstructure. The axis of the 12in. guns is 10ft. 1in. above the water-line. Armour protection is very complete, a belt 11in. thick extending the whole length of the ship at a depth of 5ft., reinforced by a 1½in. protective deck. The turret and barbette armour is 10-11in. thick, and that of the conning-tower 7in. The propelling machinery consists of two sets of vertical inverted triple-expansion engines in a single water-tight compartment. Steam is supplied by four water-tube boilers constructed for a working pressure of 250 lb. per square inch. The total grate area is over 200 square feet, the heating surface about 9000 square feet. All four boilers are housed in one compartment, and the uptakes are led into a single funnel. When completed these vessels were assigned to the Atlantic Fleet, but they were soon degraded to the reserve, and eventually became tenders to submarines. They are interesting as representatives of the most modern type of monitor in existence prior to the war, and as showing the comparatively formidable armament which can be mounted in a vessel of 3300 tons, in conjunction with robust protection, fair speed, and tolerable nautical qualities. The following table shows the development of the American monitor from 1862 to 1900:

	Original Monitor.	Dictator.	Miantonomoh.	Puritan.	Arkansas
Date of launch	1862	1863	1876	1884	1900
Length (feet)	172	312	249	280	255
Breadth (feet)	41½	50	55¾	60	50
Draught (feet)	10½	20	14	18	12½
Displacement (tons)	1000	4500	3990	6060	3356
I.H.P.	—	1000	1600	3700	1712
Speed (knots)	6	7–8	10½	13	12
Thickest armour (inch)	8	8	11½	12	11
Armament	2 11in. M.L.	2 15in. M.L.	4 10in. B.L.	4 12in. B.L.	2 12in. B.L.

* In a letter dated January, 1862, Ericsson wrote:—"To the Lords of the (British) Admiralty, the new craft will be a monitor, suggesting doubts as to the propriety of completing these for steel-clad ships at three and a-half million (dollars) apiece. On these and many other similar grounds I propose to name the new battery 'Monitor.'"

† Brassey, "The British Navy."

AN EARLY PROPOSAL FOR A VEHICLE WHEEL

(For description see opposite page)

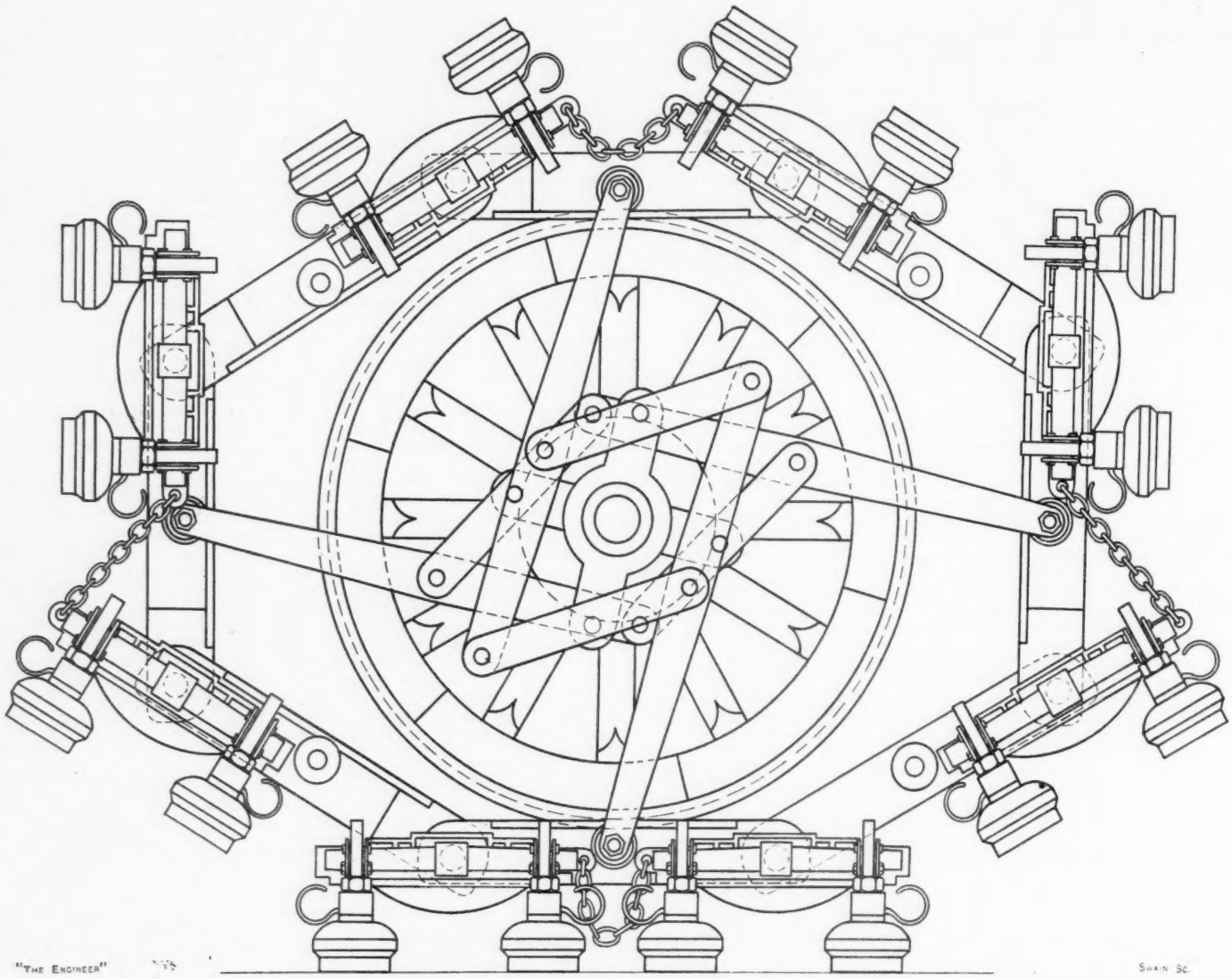


Fig. 2—THE ANDREW DUNLOP WHEEL OF 1861

Turning now to the monitors engaged in the present hostilities, it is naturally impossible to enter fully into details. The Severn, Mersey, and Humber were the first vessels of this type to be placed in service for the British Navy at the outbreak of war. They had been ordered by the Brazilian Government from Vickers Limited, and were launched in 1913 as the Solimões, Madeira, and Javary, but were purchased by the British Admiralty in August, 1914. The following particulars are summarised from a lengthy description which appeared in the "Navy League Annual" for 1913, and other publications, in connection with their launch:—Length 265ft., breadth 49ft., depth 8ft. 6in., with a displacement of about 1250 tons. The designed speed is 11.5 knots, with a radius of action of 4000 nautical miles at economical speed. A double bottom extends almost the entire length of the vessel, providing stowage space for feed-water, oil fuel, &c. This double bottom construction is continued up the sides to the upper deck in way of the engines, boiler spaces, and magazines, thus adding to the safety of the ship. The hull, moreover, is separated into a large number of water-tight compartments by traverse and longitudinal bulkheads extending up to a complete steel upper deck, and these compartments form the various store rooms, magazines, bunkers, auxiliary machinery spaces, &c. The armament consists of two 6in. quick-firing guns mounted in one armoured turret on the upper deck forward, and with electrical machinery for working the guns; two 4.7in. howitzers on the upper deck aft, four 4.7 mm. quick-firing guns on the boat deck, and six machine guns. The sides amidships carry heavy armour, extending from the upper deck to well below the water-line. Forward and aft of this belt armour bulkheads are fitted, and there is thinner plating over the rest of the exposed hull. The upper deck of nickel-steel armour affords protection to the various compartments. Unusually commodious quarters were provided for the officers and crew, and great care was bestowed on the ventilating arrangements, as the ships were, of course, intended to serve in a district where the climate is extremely warm, and the atmosphere very humid. Fate, however, decreed that these powerful little vessels should receive their baptism of fire in colder latitudes. They formed part of the "scratch" squadron which, under the late Rear-Admiral Hood, stemmed the German advance along the Belgian coast, inflicting extremely heavy casualties on the enemy, and causing great damage to his transport and material. Owing to their very light draught the three monitors were able to get well inshore and use their guns almost at point-blank range, until the enemy, by bringing up very heavy artillery, compelled them to keep further out. In these operations, which unquestionably hampered the German advance to a most serious extent, the Mersey was the only vessel to receive important damage. According to Rear-Admiral Hood's despatch, her 6in. turret was disabled, and she had several hits on the water-line. Ten months later the Severn and Mersey unexpectedly appeared in the Rufiji estuary, East Africa, where they succeeded in totally destroying by gunfire the German cruiser Königsberg, which had been blockaded in the river for nearly a year.

Of the larger monitors, built specially for the war, it is not permissible to give details, though some idea of their main features was obtained from Mr. Ashmead-Bartlett's letters from the Dardanelles. Jane's "Fighting Ships," for 1916, mentions the General Crauford, Lord Clive, and other vessels which have been specified in despatches, and adds the following note: "According to published descriptions, these vessels are high-freeboard, sea-going vessels. Their beam is large, and they are said to manœuvre indifferently. It has been publicly stated that 15in. guns, intended for the new 'Royal Sovereign' class of dreadnoughts, were appropriated for arming these ships. The 14in. guns, ordered in America for the Greek battle-cruiser Wasilefs Giorgios (ex-Salamis), building in Germany, were also purchased for these monitors." Other vessels, presumably of a much smaller type, have been alluded to in official despatches from almost every theatre of the naval war—one, the M 30, was reported as sunk by Turkish gunfire in an Admiralty communiqué of June 3rd, 1916. In certain quarters severe strictures were passed upon the Admiralty for having spent so much time, money, and labour on the creation of this fleet of monitors, the critics maintaining that the vessels in question were of extremely limited value. This contention, however, is not borne out by our knowledge of what the monitors have accomplished. At Gallipoli, when the appearance of German submarines compelled the Allied squadron to withdraw temporarily, the position of the invading army, bereft of naval support, would have become highly critical had it not been for the timely arrival of our monitors. Indeed, it is not too much to say that their presence saved the situation. Practically immune from torpedo attack, they were able to maintain a steady bombardment of the Turkish positions with their big guns, and it was largely owing to their efficient work that the evacuation was carried out so successfully. Nearer home the monitors have rendered services scarcely less valuable. No other vessels could have been used effectively against the German fortified positions on the Flanders coast, and without their vigorous and repeated bombardments the enemy would have been able to establish himself much more firmly at Ostend and Zeebrugge than is actually the case. The recent brilliant advance in Mesopotamia, culminating in the occupation of Bagdad, owed much of its success to the fine work of the smaller monitors operating on the Tigris. On the whole, therefore, the Admiralty's policy of building monitors has been completely vindicated, and it is doubtful whether their period of usefulness is yet at an end. As a rule, naval bombardment does not give results proportionate to the energy expended, but the novel methods employed both at Gallipoli and off the Flanders coast, where—as has been officially stated—aerial units were employed to control the fire of the monitors, made this form of attack unusually effective. In fact, after the last heavy bombardment of Ostend, it was established by aerial reconnaissance that the Germans had withdrawn all their naval vessels from the port.

For the amphibious operations in which this war has been so prolific the monitor is admirably adapted, and we owe it to the prescience of the Admiralty experts in the first few months of the struggle that we possessed these valuable auxiliaries at a period when their services could not well have been dispensed with. Space does not allow us to describe at any

length the river monitors which Austria, Russia, and Roumania have employed in the Near East. The Austro-German invasion of Serbia was materially assisted by a flotilla of light-draught monitors, two of which, the Temes and Körös, were sunk by torpedoes discharged from British picket boats. Students of naval history will detect a close analogy between these Danube operations and those which gave the Union forces the mastery of the Mississippi in the American Civil War. It remains to be seen whether the monitor will hold its own as a standard type in the British Navy after the war. The construction of such vessels, or, at all events, of some form of well-armed shallow-draught vessels for inshore fighting, was advocated a few years ago by Lord Brassey and other naval publicists, who foresaw that the orthodox doctrines of the "blue-water" school took no account of the peculiar strategical problems which would arise in the event of such a war as this. In the Franco-German War of 1870-71 the failure of Admiral Bouët-Willaumez's squadron to achieve anything on its expedition to the Baltic was a direct consequence of the failure of the French naval authorities to provide themselves with vessels suitable for coastal operations.

Until the year 1913 the bulk of the flake graphite of the world came from Ceylon, the output from that island being from thirty to forty thousand tons per annum. In 1907 Madagascar produced eight tons of flake graphite and slowly increased the output until 1911, when the four figure mark was reached, showing 1246 tons; in 1913 the yield had gone up to 6313 tons; in 1915 to 11,851 tons; and in 1916 to the respectable figure of 25,489 tons. The graphite, says the *South African Mining Journal*, is found plentifully distributed over the crystalline schists of the island, and as these schists occupy about two-thirds of the island, or roughly over an area of 200,000 square miles, some idea of the extent may be imagined.

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. II.*

In our first article we discussed the various proposals which had been brought forward, during the ninety years prior to the year 1860, for increasing the bearing surface of the wheels of vehicles. We showed that even at that early date practically the same ideas had been patented by different persons at various times. The same practice is to be noticed in the later history of the subject, which we shall now proceed to consider.

Andrew Dunlop, of Glasgow, devoted a good deal of attention to the matter during the twenty years or so following the year 1860, and he took out three patents for what are certainly most ingenious contrivances, though they were complicated in detail, and, we should judge, would have required a considerable amount of power to work. The first patent was No. 1187 of 1861, and it was for "Improvements in Endless or Portable Railways for facilitating the Traction and Draught of Vehicles." The device proposed was, as shown in Fig. 2 which has been reproduced from one of the drawings in the patent specification, to be applied apparently to all the wheels of a vehicle. Each wheel was made to run on a series of short rails which were jointed together at the ends, so as to form a flexible band surrounding the periphery of the wheel. The inventor preferred to have eight "rails" to each wheel, and they were formed of wood, cased with iron, being connected together in pairs by means of malleable iron rods, the pairs being formed by two rails diametrically opposite to one another. In the drawing only two pairs of rods are shown, the others having been omitted for the sake of clearness. The connection between the rods and the rails was made at the centre of the latter, and the rods extended inward towards the centre of the wheel, where they were connected by a movable link to each other. The links were also joined at their centres to a ring having two laterally diverging arms, and arranged to run loosely on the axle. This arrangement the inventor pointed out was adapted for wheels which were keyed to their axles. When the wheels ran loosely on their axles the ring was made to run on a bush projecting laterally from the nave of the wheel and encircling the axle. The rods with their connecting links formed a series of parallelograms round the axle, the motion of the wheel causing the several pairs of rails to move regularly round its periphery. The ends of the rails where they were joined together were furnished with adjustable chairs which supported the rails a short distance above the ground, and adjusted themselves to the inequalities of the surface. The overlapping ends of each pair of rails were bored to admit of a bolt passing through the holes. This bolt formed the axis of the joint, and its extremities were supported in two short iron beams, arranged one on each side of the ends of contiguous rails. The beams were formed with screwed ends, and were attached by nuts to a curved plate at each end. These curved plates, which passed below the rail, were in the form of segments, and their extremities expanded to about the level of the upper surface of the rails. Each curved plate rested in an adjustable chair, the inner surface of which was given a curvature similar to that of the plates. In this way the chairs were movable about the plates to a greater extent than would otherwise have been possible, and motion was facilitated by fitting to the upper part of the chairs on each side an anti-friction roller, which moved over the inner surface of the segmental plates. The chair consisted of two side plates with these anti-friction rollers between them, and at the lower part it was provided with pendent lugs to which were jointed metal blocks, each of which was formed with laterally projecting journals which supported a metal

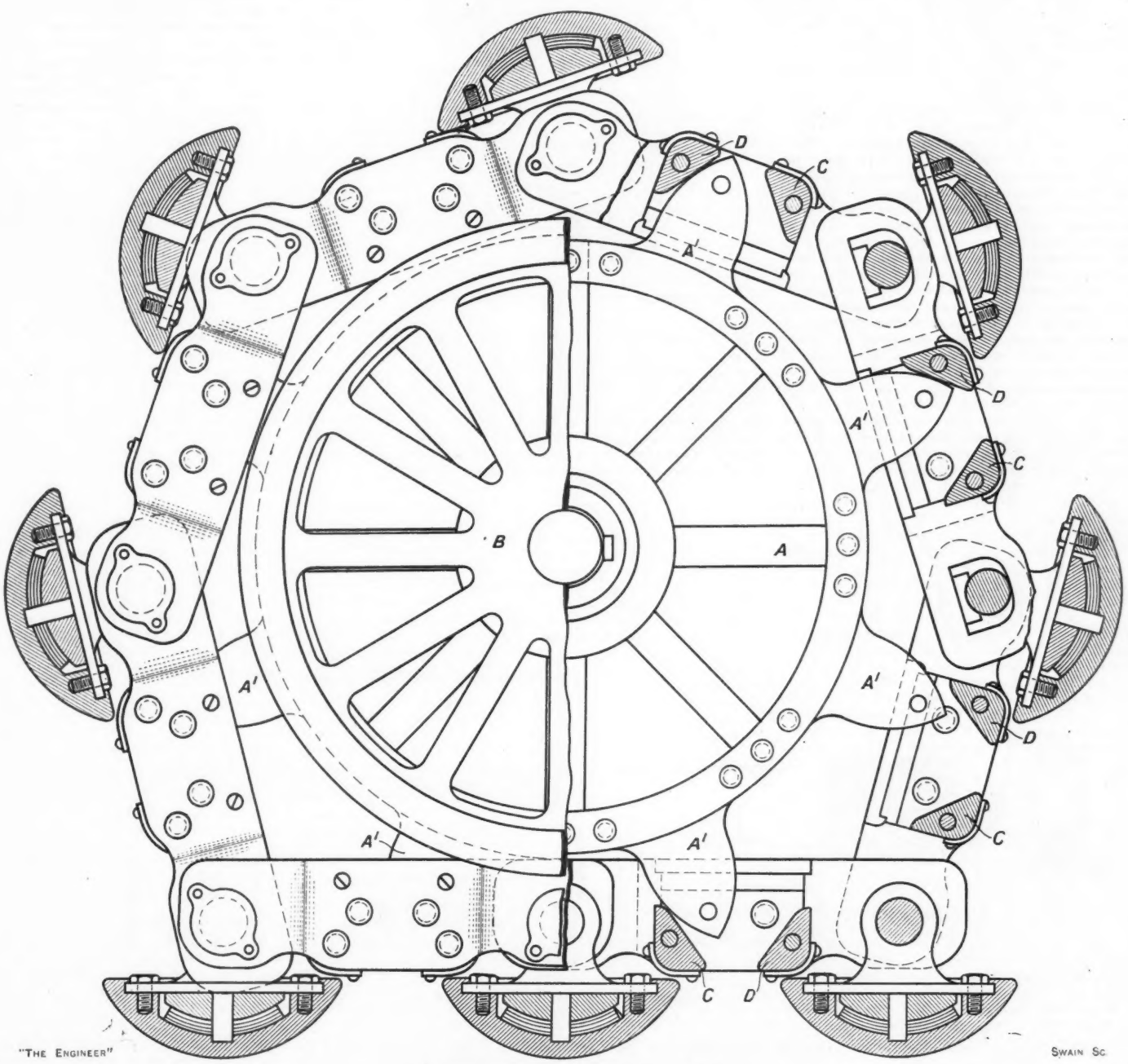


Fig. 3—THE ANDREW DUNLOP WHEEL OF 1874

* No. I. appeared August 10th.

ring that moved freely about them. The rings rested upon the ground, and their connection with the side plates of the chair gave them the flexibility of a universal joint. Each chair rested upon two of these supporting rings or feet, and there were two chairs to each joint of the rails. As the vehicle progressed the feet were successively brought to the ground, and if one of them rested on a stone, the rollers moved up or down the curved guides, the flexibility of the foot assisting this action. The inventor claimed, in fact, that whenever inequalities of an ordinary nature were encountered the rails remained level, or nearly so, and did not in any way impede the motion of the vehicle.

Thirteen years after taking out this patent, Mr. Dunlop took out another—No. 657 of 1874—with the same title. His design of wheel had in the meanwhile undergone a good deal of modification, though the central idea remained the same. Again the epithet ingenious can well be applied to the suggestion, but it was cumbrous, and would have been expensive to make. A drawing of the wheel is given in Fig. 3, and a cross-sectional view showing one method of constructing the "rails" in Fig. 4. There were to be eight or more "rails" surrounding each wheel, these rails being jointed together in such a manner as to allow them to bend round the wheel as they were laid on or lifted from the ground, and also to bend laterally at the joints when the vehicle was turning round corners or in a circle. Each wheel was made up of three separate wheels. There was first of all a central wheel A, with comparatively narrow rim arranged in between two other wheels, B and B^1, with much wider rims. This central wheel was keyed to the axle, and had spear-shaped, or as the inventor himself called them, "tooth-like" projections, A^1, A^1, A^1, arranged at regular intervals round the periphery. These projecting teeth worked in between two bevelled cross-bars, C and D, which reached from side to side of adjacent links of the rails, and they acted exactly as do the teeth of a sprocket wheel, arranged to engage with a chain. When, therefore, the wheel was revolved the series of rails was also made to revolve. The two outer wheels were free on the axle, and they were arranged to roll on the rails, being furnished with outside flanges which embraced the former. The rails were fastened together in an endless chain as in the earlier patent, and at each joint there was also pivoted a rounded or flat foot.

Dunlop's third patent was numbered 1014 of

In this same year—1882—a patent was taken out by Mr. John Clayton Mewburn, the invention having been made by Guillaume Fender, of Buenos Aires. The specification is numbered 1168, and it contains several points of interest. The object of the invention was declared as being "to enable road locomotives, wagons, agricultural engines, and other like vehicles to possess the advantages of running on rails, and at the same time to retain their power of travelling on ordinary roads," and it was explained that the invention consisted essentially in the arrange-

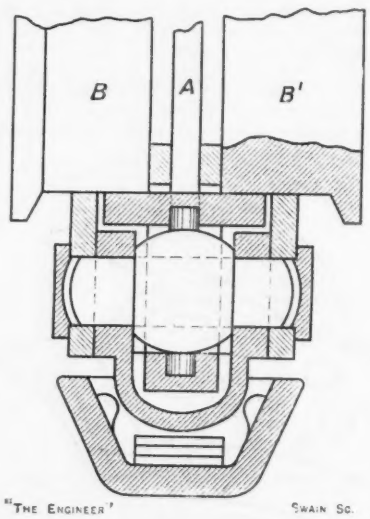


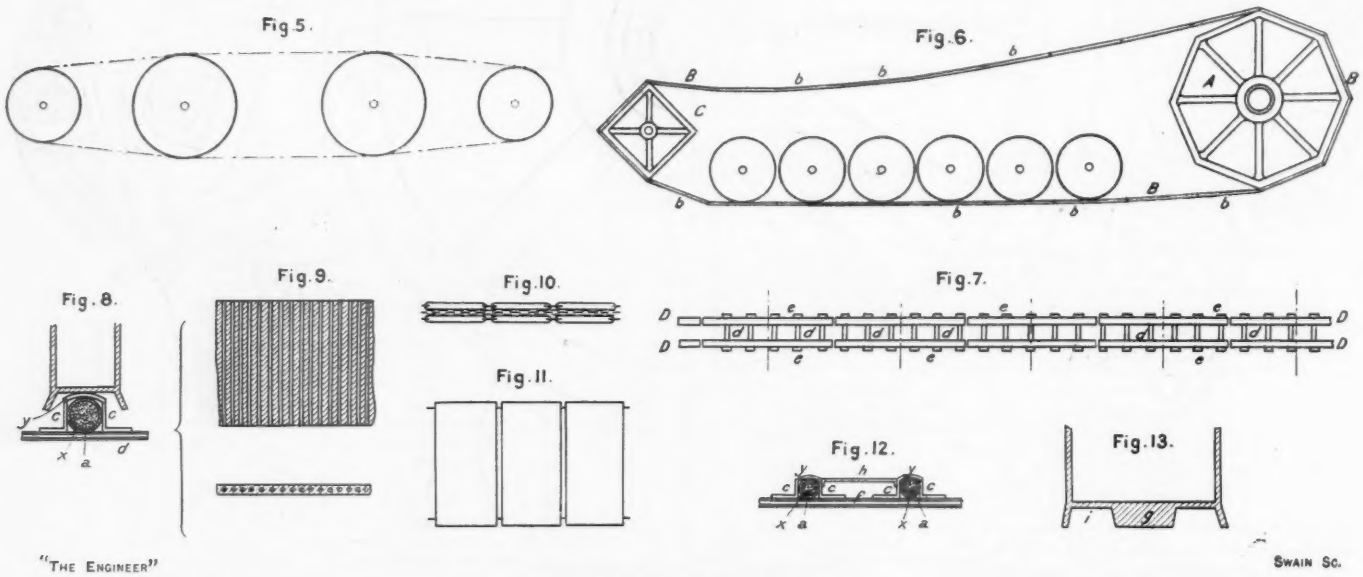
Fig. 4—SECTION OF RAIL OF DUNLOP WHEEL

ment of endless cables or chains which formed the railway, and in the means by which they were continuously taken up and relaid in front of the wheels of the vehicle. We reproduce in Figs. 5 to 13 inclusive the whole of the drawings which accompany the specification. Having regard to the form of present-day chain tractors, Fig. 5 of these drawings, which is described as being a diagram of the arrangement of cables applied to a locomotive, is distinctly

diameter of the wheels, and over this drum passes the endless railway B, which is formed in lengths, *b b*. At the rear of the locomotive is a smaller drum C, which lifts and supports the railway. He proposes that, in order to protect the rails from injury or shocks, caused by hard or uneven bodies, they should be fixed on an elastic and resisting material. For this purpose, he says, a band may be formed "by the juxtaposition of iron wire ropes the combined width of which is equal to the width of the base of the rail," but he states that, though he suggests iron ropes, other materials will answer the purpose. It is well, he adds, to employ flat rails, so as to prevent them getting out of place.

In order to enable the locomotive to ascend inclines, each rail might be formed as shown in Fig. 7. The two endless chains, D D, are connected together by a number of small cross-pieces or stays, *d d*, so that a travelling rack is formed, upon which the wheels of the locomotive run, the wheels being formed with corresponding teeth. Again, stress is laid on the fact that the lengths *e e*, of which the chains are formed, are always to be equal to the distance between the axles. In the figure the position of the axles are indicated by dotted lines.

The wire rope rails may, it is explained, be made in the manner shown in Fig. 8. Upon the rope "*a*" are placed metal rings, "*x*," to each of which is fixed by soldering, or otherwise, two side plates or checks, "*c c*," and at the top a cap, "*y*," having the form of a rail-head. In such a case as this the wheels should have felloes shaped as shown, "so as to be maintained on the rails thus formed." The object of the side plates, "*c c*" is, it is pointed out, to give more stability to the rings and to the cap or top plate; at the same time to distribute the pressure over all the breadth of the bottom piece, "*d*," to which they are strongly screwed. The bottom piece "*d*" was to be formed of an endless band, which might be made of "gutta-percha, felt, woven wire, or other suitable material." In some cases, adds the inventor, it may even be made of straw. The bottom piece, however, must, he adds, be bound or strengthened externally, and sometimes internally, as shown in Fig. 9. For this purpose, he continues, the wires used may be, say, 18in. long, with flattened ends, which are fixed to the bottom piece side by side, but without interfering with the flexibility. Or the place of the wires may be taken by boards rounded at the sides as in Fig. 10. Instead of the endless



GUILLAUME FENDER'S PROPOSALS—1882

1881. It discussed modifications of the 1874 patents, and need not be referred to in detail.

Another patent having an exactly similar object to those of Dunlop was that of Richard Waller, 1688 of 1877. Its full title was "Improvements applied to wheels and other forms for rolling over railways, tramways, common roads, or any soil whereby increased traction surface or tractive adhesion is obtained for mounting steep gradients and travelling over uneven surfaces." The nature of the proposals is clearly indicated in the opening statement of the patent, the gist of which is as follows:—The invention is based on the use of a belt, band, or endless chain formed of a number of blocks or wedges connected by links or otherwise, or interlocking the one with the other in combination with the rolling parts of an engine or vehicle in such wise as to form a tyre, the traction surface of which, that is to say, the extent of its periphery, resting at one time upon the ground during a revolution, may be greatly increased without a corresponding increase in the diameter of the wheels or rolling parts of the machine or vehicle. The invention claimed to arrange for "any desired length or breadth of surface upon the road."

interesting, for there are the road wheels, the continuous chain, and other wheels at either end which took up and relaid the endless railway and kept it clear of the road, an arrangement which would, of course, assist in surmounting obstacles.

The inventor, in his specification, asserts that in the attempts which had up to that time been made to construct endless travelling railways, and which had been abandoned, the rails employed had always been too short. He himself proposed that the length should be the same as the distance between the axles of the vehicle. If it were desired to have short links, then the number of wheels must be increased. He suggested that the rails might be cut in lengths of, say, from 16in. to 24in., and he proposed that, should the locomotive be used for hauling a train of wagons, the endless railway should be long enough to embrace *all* the wheels, so that it would be "a little more than twice the length of the train." One shudders to think of the loss in friction which would be involved in such an arrangement!

Going in detail into the invention, the patentee draws attention to Fig. 6. He explains that the steering wheel of the road locomotive is replaced by a polygonal drum A, which is five or six times the

band, the bottom piece may be formed of transverse laths, connected together, so as to form an endless series—see Fig. 11.

Where inclines had to be ascended the inventor employed two or more endless chains, connected together at regular distances apart by iron or steel bars, so as to form a sort of endless ladder. The wheel felloes were made with teeth or projections which took on to the bars of the "ladder." The arrangement he proposed is shown in Fig. 12, in which *f* is the outer shoe constituting a kind of iron sleeper, to which are fixed the way formed as in Fig. 8. The cable is shown at *a*, the rings at *x*, the soldered side pieces at *c c*, and the cap at *y*. Bars *h*, of steel or iron, connect at regular distances the two cables to each other, and form the rounds or steps of this sort of ladder. Fig. 13 represents the felloes of one of the wheels. It has teeth or projections "*g*" in the middle, and two gaps or spaces, "*i i*," to allow the endless railway to pass.

A peculiarity of this specification is that, although as seems clear from the main body of the text, Fig. 5 is diagrammatic, it should so closely resemble in outline the form of tractor now employed when it is desired to surmount obstacles.

THE INDUSTRIAL OUTLOOK.

By CHARLES H. HADDRELL, A.M.I.E.E., F.R.C.I.

[IT is good for us all, now and then, to see ourselves as others see us. The author of the following article has, we believe, the welfare and prosperity of this country at heart, and his criticisms for that reason will be taken in good part. He has spent twenty-five years in engineering and manufacturing in New Zealand, in England, and in the United States, so that he speaks from mature knowledge, not only of this old country, but of those that are later comers in the industrial world.—ED. THE ENGINEER.]

The principal industry of Great Britain is manufacturing, and upon the success of this depends the prosperity of the country. Dependent upon, and developed by the manufacturing, is the great secondary industry, transportation. It has been apparent for a number of years that British industry has been losing its position in the world, and also that the lack of organisation is responsible for this unfortunate condition.

A comparison of British manufacturing with that of the principal competitors shows that several countries are increasing the value of their manufactures relatively much faster. The value of the output per person employed is a fair indication of the efficiency, and the values based upon official returns are not at all comforting to the British manufacturer. From available returns it is found that the value of the products of British workers is only from one-third to one-half that of American workers in the same lines. In some cases it may be argued that the high rates of wages and the corresponding high selling prices is the cause of the apparently greater value of the American output; but this is not the case, for some articles are sold at prices which do not exceed British prices for similar goods. Cotton goods, for instance, can be purchased in the United States for about the same as in England, but the value of each worker's product is placed at £2 13s. 9d., whereas the product of each British worker is only £1 10s. 5d. Boots and shoes of good quality cost no more in America, but one American worker produces shoes to the value of £3 10s. per week, while the British worker produces only £1 7s. 6d. worth of boots. The same ratio appears to exist in may other lines.

Investigation shows that the American worker uses three or four times as much power as the British worker, or in other words, the American factory is provided with much better equipment, and machinery is used to a much greater extent.

It is, therefore, evident that the British manufacturer should equip with modern machinery, and train operatives to use such machinery, to their mutual advantage. The cost of operating machinery is only a fraction of the cost of man power, and if the value of the product can be increased three times by the use of four horse-power per worker, instead of one, a very material reduction in cost will result.

The British manufacturing industry shows a lamentable condition of inefficiency, but although American industry is given as an example of efficiency, it must not be assumed that all American factories have attained the highest possible efficiency, for some of them are in many respects very wasteful, and many of them would be unable to exist under real competitive conditions. As there is no effect without a cause, so there is no trouble without a remedy, and it is therefore incumbent upon everyone to strive earnestly for the improvement of the condition of the manufacturing industry, upon which the welfare of the country depends.

FINANCIAL ORGANISATION.

It is apparent that the primary cause of the present condition is lack of financial organisation. The bankers have not realised that their own ultimate prosperity depends upon the welfare of the country in general, and of the manufacturers in particular. The attitude of the trades unions is a contributory cause of the lack of progress; they have deliberately limited output, and introduced other practices detrimental to the industries of the country. These errors are due to ignorance and lack of education, and will undoubtedly disappear with improved conditions.

The manufacturers are by no means blameless for the attitude of the workers, for there are very few firms that have, in the past, pursued an enlightened policy as regards their employees.

The restoration of the British manufacturing industry is in the hands of the financial organisers, and cannot be obtained by the appointment of Government Committees, or by the formation of voluntary associations of manufacturers, although the latter move is a very good one, and will, undoubtedly, result in some improvement. Reorganisation should follow the plan of consolidation; one strong combination is better able to compete in the markets of the world than the several smaller units of which it is composed. This plan is not in accord with British public opinion, but it is necessary in these days of intense competition thoroughly to organise the efforts of the country, in peace as in war, and the effectiveness of this system has been fully demonstrated by the large munition factories during the war, as well as by the large American industrial combinations during the past ten or fifteen years. Nothing like such good results could have been attained in the output of munitions if every small manufacturer in the country had worked to the limit of his capacity, independent of every other factory.

A few examples of specific industries which would be benefited by a complete reorganisation may be of interest.

ELECTRICAL ENGINEERING.

Electrical manufacturing has never reached a satisfactory position; the majority of British electrical manufacturing companies are financial failures; reorganisations calling for a writing down of the capital stock, or for an assessment of the stockholders, have been much too frequent. The remedy is to have fewer manufacturers, and each one to have sufficient strength and resources to be able to manufacture standardised products, and to educate and convince purchasers that he is working for their benefit as well as for his own.

The electrical manufacturers have been fighting among themselves for the small home market, instead of going out into foreign markets and bringing home the trade of the world. A few powerful firms would be of inestimable value to the country, and a capitalisation of from £10,000,000 to £20,000,000 sterling for each would not be excessive; a period of from five to ten years would be required to get such concerns into a good working condition.

LOCOMOTIVE BUILDING.

The manufacture of locomotives is another industry that is sadly behind the times; there are probably more builders of locomotives in Great Britain than in the United States, but a comparison of the production shows that British works are only playing at locomotive building. There is only one firm that has shown any realisation of the trend of the times, and that one is undoubtedly more prosperous in consequence. In the past twenty years no British locomotive builder has been able to obtain competitive orders, based on either price or delivery. A Dominion Government that has always favoured British builders has been repeatedly compelled to place orders in America, and, when the orders have been divided, the American engines have been placed in service twelve months before the British. The English railway companies could not afford to build their own engines if the locomotive manufacturers were able to produce engines as they should.

As a more or less typical example of railway methods of building, the following may be of interest. Some sixteen years ago one of the great English railway systems built a locomotive for the Paris Exhibition; a set of drawings was made, and the engine was built, but as it did not look right, it was partly pulled down and rebuilt without drawings; then, when the engineers were satisfied, a new set of drawings was made from the parts. The same company about this time informed an applicant for a position in their drawing-office that they had hired a draughtsman, nineteen years previously, but as he had not proved very successful they would not hire another. Vacancies in the office were all filled by pupils of their own training—a statement well borne out by the experience in building the locomotive mentioned above.

SHIPBUILDING.

Shipbuilding has been the pride of British industry for many years, but there are competitors coming to the front, and if the premier position is to be maintained, shipbuilding must be advanced and improved methods more generally adopted. There is no good reason for a new design for every ship, and there would be great economy in building standardised ships of 1000, 2000, 4000, 8000, and 12,000 tons for freight and passenger service; such ships could be built in much less time and at a greatly reduced cost, compared to present practice. The present is the best opportunity that has ever been given to make radical changes. Shipbuilders must not let it pass. Manufacturers, who expect to obtain foreign trade, must learn to study the needs of the markets, and then to furnish what is required, otherwise competitors will get the trade, and a market, like a customer, once lost, is very difficult to regain.

THE SCRAP-HEAP.

The British motto in the past has been "the best is none too good," but a better one would be "good enough is best," for there is no reason for making anything better, or more costly than necessary, so long as it will satisfactorily perform the service for which it is required, it is as good as anything that can be made. Machinery of many kinds is now made with a view of ten or possibly fifteen years service instead of for a lifetime, as was the practice not many years since. Ultimately economy is the aim of the most practical engineers to-day, and equipment that is the very latest and best now will be obsolete to-morrow.

About fifteen years ago the Interborough Rapid Transit Company, of New York, installed a number of large engine-driven 5000-kilowatt generator sets. The demand for power has increased so rapidly that a much greater capacity is now required, and it has been found possible to replace the 5000-kilowatt sets with 30,000-kilowatt turbine-driven generators. The ultimate output of the station has thus been increased to six times its original capacity. The cost of the original plant was about 40 dols. per kilowatt, whereas the new machinery cost only 9 dols. per kilowatt; moreover, the coal consumption has been reduced from 2½ to 1½ lb. per kilowatt hour. It was, therefore, good engineering to replace the old apparatus with modern equipment.

Machine tool practice furnishes a more familiar example of the usefulness of the scrap pile; lathes and many other machines designed fifteen years ago are unable to meet the requirements of the modern machine shop, as they are incapable of standing the stress of operating with high-speed steel tools at maximum capacity.

The development of electric power stations has been phenomenal, and there are now stations with sets of 35,000-kilowatt capacity in operation, and it is highly probable that manufacturers will be called upon to build machines of 75,000 and 100,000 kilowatts, and machinery like this can only be furnished by large concerns having considerable skill and experience. We can never expect to reach finality, and the designer who insists on introducing his very latest idea into every new piece of apparatus will never get anything on the market. The scrap heap is a good thing, but it should be used periodically rather than continuously.

LARGE ORGANISATIONS.

In Europe and in America the tendency has been toward very large organisations, and the success of these large concerns has been quite remarkable. This can only be ascribed to the fact that the large corporation is an economic factor, by means of which unnecessary competition is eliminated and a large production is assured. It must also be conceded that the large industrial organisation is a natural development, and if we oppose progress we are placing ourselves in the same position as the cotton spinners, who fought against the introduction of Arkwright's spinning machines. Prior to the introduction and use of machinery, a master workman, with one or two apprentices, could successfully compete in the markets of the world, and there was no advantage in having a large factory, so far as the cost of production was concerned. A careful study of conditions prevailing during the past fifteen years leaves the firm conviction that the large industrial combinations are not only necessary, but that such concerns are essential for the good of the country, the welfare of the nation, and the advancement of the arts and sciences. In the manufacture of standardised apparatus it is necessary to make use of special machine tools in order to manufacture at the lowest possible cost, and the organisation with the greatest production can best afford to employ highly special machinery. Nearly all the large manufacturing organisations are the results of consolidations, or combinations of several smaller concerns. They are not the result of a powerful few, grasping for the control of an industry, but rather, in most instances, the only alternative to bankruptcy and ruination.

In a general way the cost of management of a large factory is proportionately greater than that of a small factory. But this is true only so long as a variety of products is made. When a factory confines its production to a speciality, the cost of management is materially reduced, and at the same time a larger production is obtained without increasing the number of people employed. The electrical manufacturing industry is a good example of this, and the large manufacturers are in reality specialists with several distinct lines of manufacture, and, in addition, a general production, confined to electrical, or closely allied with that class of apparatus. The general production usually consists of large and special machinery, which of itself is not necessarily profitable, but it assists the sale of standard apparatus, and is therefore of considerable value to the business as a whole. Moreover, this general line gives the large manufacturer a very decided advantage over smaller competitors, for it enables him to undertake complete installations and to assume the responsibility for successful operation. It is also of great value from an advertising standpoint.

In the absence of the large manufacturer, it is necessary for prospective purchasers to employ consulting engineers, and to depend upon them for everything. Such an arrangement is not always satisfactory, because, in the event of trouble, it is sometimes impossible for a consulting engineer to determine which of the numerous contractors is responsible for any particular defect. It frequently happens that an apparent defect in one piece of apparatus is due to some defect in an entirely different part of the plant, or the trouble may be caused by improper operating conditions. Pioneer and advanced work must be done by large concerns, which can assume responsibility and have sufficient confidence in the undertaking to risk money and reputation. Such work cannot be undertaken by consulting engineers, nor by contractors, without the strong support of the manufacturers.

Large corporations can afford to employ the most capable men in all departments, which are generally of sufficient size to have a number of first-class men, any of whom could assume responsibility for the

work when necessary. The large organisation has the advantage in every department of manufacture. A few large firms in place of many small ones would result in a greater volume of business, on account of the superior organisation. Firms with a business of £20,000,000, or £30,000,000 annually, are able to purchase raw materials at the most advantageous prices, and frequently realise considerable profit by purchasing largely when the market is low.

The loss of man power in Great Britain on account of the energy wasted by electrical manufacturers alone is appalling. Consider the number of salesmen in London who are following one another around, also the number of draughtsmen and engineers throughout the country who are working on designs of electrical machinery. These men are all working in keen competition with one another, instead of with the large foreign organisations which have been selling their products in England, and who have also enjoyed, in times past, a very large and profitable trade with the British Overseas Dominions. There is no good reason why several groups of four or five of the moderate-sized British firms should not combine, and then gradually absorb some of the smaller concerns. This would result in a good, healthy condition by eliminating much unnecessary competition, and would be beneficial to industry in general. Many of the advantages resulting from the operation of a few large organisations, instead of many small ones, are easily seen and readily appreciated. A strong staff would be developed by each concern, and a properly co-ordinated policy would result. Existing works would probably be specialised and each of them would be operated under profitable conditions.

STANDARDISATION.

The production of standardised apparatus in large quantities would warrant a full and complete equipment of tools and fixtures, never dreamt of under the old conditions. Patterns would be made for use with moulding machines, and workmen would become experts, with greatly increased earning capacity. The cost of manufacturing would be greatly reduced. Quantity production and reproduction is absolutely essential to success in modern manufacturing, and the most successful manufacturer will be the one who can obtain the greatest production of any one line of apparatus. One of the best examples of specialisation is found in the cotton mills. There are mills which produce only one width of cloth, and if orders are received for other widths they are transferred to other mills.

In manufacturing a considerable amount of time is spent in what is known as set-ups, and as every different article requires a set-up it can readily be seen that it is very desirable to keep machines operating continuously upon similar or repetition work. If a sufficient production can be obtained it becomes economically possible to build special machines to perform the operations automatically, or at least to perform several operations at one setting. A large production is necessary to warrant special machinery, but there is a great economic opportunity in a factory making ten thousand watt-hour meters per week, or where two or three thousand motors, aggregating ten or twelve thousand horse-power, are made every week. Such factories have existed for some years, but not in Britain. The wonderfully specialised equipment of some of the American automobile factories is well known, and a production of from one to two thousand cars per day is maintained in more than one of these immense establishments. Such achievements are genuine triumphs of organisation, for there is no monopoly, and competition is keen. A low cost has been made possible by the enormous production, and reliability has been maintained by a careful and continuous study of essentials.

The existence of an article is frequently the cause for its demand. A few years since there was no market for vacuum cleaners, because they were unknown; but as soon as they were available it was found that a considerable demand existed. It is a fair statement to say that if we can produce any article in common use, for less than the present cost, the demand for it will be increased immediately.

ELECTRICAL ENGINEERING IN GREAT BRITAIN.

Another instance of the conditions existing in the electrical manufacturing industry will demonstrate that the British manufacturer has not realised the possibilities of the industry. The production of continuous-current motors in Britain is much larger than that of alternating-current induction motors, whereas the contrary should be the case. Considering the world at large, alternating-current apparatus is predominant. All the new power stations of any appreciable size furnish power from alternators, driven either by steam turbines or by water wheels, and although a certain amount of continuous current is supplied through converter sub-stations, it is considerably more economical to transmit high-tension current and employ step-down transformer sub-stations. The demand for induction motors is already great, and will undoubtedly increase very rapidly. South Africa, Australia, Canada, and many other countries are growing markets for this class of apparatus.

The electrical branch of the engineering industry is now of great commercial importance, and it is rapidly becoming more important. It is very unfortunate that there are no electrical manufacturing firms that can rightly be called pre-eminent. There are many small concerns, but none comparable with the leading firms of the world. Some of the leading British firms have not paid a dividend for ten years, and it cannot be expected that capitalists will be interested in such industries. The past history of the electrical industry has been such that it will be very difficult to eliminate the mistrust existing in the minds of investors. Lack of organisation in the past is responsible for the conditions, and a complete reorganisation of the industry is necessary.

LABOUR.

So much has been written regarding efficiency that the subject has been worn threadbare, but there is no doubt that British manufacturers have lost the high position they formerly held in the industrial world, and radical changes are necessary if that position is to be regained.

When the war is over the Germans will of necessity exert themselves to the utmost in the endeavour to maintain their position and to win new markets for their manufacturers. British manufacturers must meet the situation, and it is only by means of organisation, including production, transportation, and the financial branches of industry that the competition can be met effectively. The labour problem is a serious one, but if the manufacturers will remember the lessons of war-time conditions, the problem will be solved without much difficulty. A well-organised industry should be able, by fair dealing and the use of reasonable incentives, to retain the loyalty and co-operation of its workers. There should be no limitation of output, and no limitation of the earnings of the workers. Human nature will assert itself in spite of trades union rules, providing the incentive is sufficiently strong.

All manufacturers should adopt a system of training workers of all classes, including apprentices and machine operators. The training of employees is a very important subject, and quite beyond the scope of this article; but it can be definitely stated that much of the training is necessarily special, and obtainable only under actual working conditions. The premium system of apprenticeship is utterly worthless, and should be entirely abandoned. The human element must always be considered the most valuable and essential feature of any manufacturing organisation. The safety and comfort of employees should be carefully studied, and improvements along these lines will be found very profitable, and also a source of mutual confidence, which is essential to permanent success. Many of the most serious strikes could have been avoided if the employers had known how to manage men and win their confidence; but the study of men was neglected, and trades unions are the result. The unions have compelled employers to treat workers much better than formerly; but how much better it would have been if the employers had forestalled the unions, by instituting improvements and social betterment work. If men feel that their employers are really interested in them and their welfare they will not join organisations for protection, but will stand by the employers in times of trouble. All industrial firms should have a pension system for employees, as well as mutual benefit societies, operated by employees under the supervision of the management.

CO-OPERATION.

The employment manager in a large concern has a very important position, and upon the results of his selection a great deal depends. Workers must be selected with as much care as to their fitness as is given to the choice of materials in the construction of modern machinery. Very few people are in a position to know what work they are best fitted for, and hence the employment office must be in a position to judge of the qualifications of candidates for employment, and this cannot be done without making a few tests.

One of the first essentials for success of a large corporation is the co-operation of everyone in the organisation. A small concern can succeed if the owner or manager is capable, and exercises a careful supervision over everything; but the large concern depends entirely on the active co-operation of the employees, for it is entirely beyond the capacity of any manager to exercise direct supervision, or to keep in touch with the employees generally. Co-operation has been a predominant factor in the history of the world. Its influence is clearly seen in both civilised and savage races. It is one of the fundamentals of common sense, and its benefits are self-evident. Our forefathers realised the necessity for co-operation, in olden days, when the several units of a family united to protect their common interest, and to a still greater extent when the families of a district combined as a tribe to fight the common foe. Co-operation is a natural instinct, and almost as strongly defined as the law of self-preservation. British manufacturers have not realised, until very recently, the necessity for any co-operation, and the result is a large number of units without any intelligent co-ordination.

Organisation is one of the first results of an efficient co-operation, and no large undertaking can be successful without it. British engineers are without doubt individually equal to those of any of the leading countries of the world, but they are apparently all devoted to engineering pure and simple, and consequently have failed to see the greater commercial possibilities open to engineers possessed of organising abilities. The individualistic tendency and independence of British capitalists and manufacturers have been very unfortunate for the country at large, and these traits have been responsible for the loss of the leadership of the industrial world, far more than the policy followed by the trades unions. There has been considerable discussion regarding co-operative associations for the manufacturing and engineering industries, the idea being that foreign trade could be fostered and extended by such associations. It is very probable, however, that many of the members of these associations would be sadly disappointed if they relied upon such means for getting business.

FOREIGN MARKETS.

Foreign trade should be organised along national lines, but individual manufacturers must send out representatives and salesmen to obtain orders, and they must also be prepared to furnish efficient service to customers. Service is to-day an all-important branch of any business, and no manufacturer can afford to neglect it, for it should be remembered that when the manufacturer has delivered his order his connection with the customer is only beginning, and if he is successful in keeping the customer's good will, he can rely upon receiving further orders, as well as recommendations to other possible purchasers. One of the best methods of getting foreign business is for the manufacturers to have contracting firms associated with them. These contractors can secure orders for the installation of complete equipments, obtaining the different types of apparatus from their associated manufacturers. This relieves the manufacturers of the necessity of doing work for which they are not well equipped.

Another method is for some firms to manufacture for the home market, while others devote all their efforts to foreign markets. This is a somewhat difficult arrangement, but it is sometimes adopted with good results, and it has the advantage of lower manufacturing costs, by eliminating some of the different types which must be manufactured when catering to both home and foreign trade. There is an insistent call now for a Ministry of Science and a Ministry of Commerce; but although these steps may help in the restoration of British industry, it must be admitted that no Government Department can effectually control industry without handicapping business to a very great extent. The Board of Trade as at present constituted is not all that could be desired; but it can be remodelled, and with the assistance of a commercial consular service would become as efficient as any State department.

CONCLUSION.

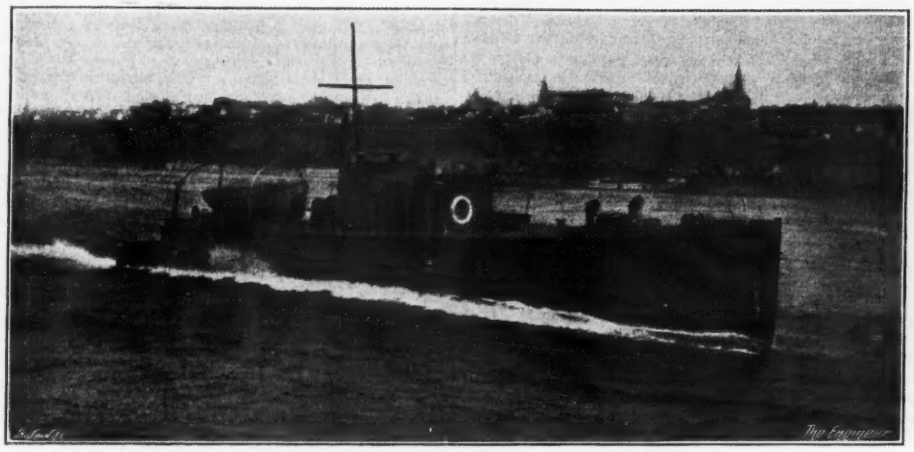
The engineering industry had its birth in England, and during its infancy it was carefully nursed by British engineers, but it has not been properly matured by the capitalists and bankers. There is need of men to organise industry, as Earl Kitchener organised the Army of Britain. It is a task that will require time and patience as well as financial skill, but it must be done. The late J. P. Morgan organised the steel industry of the United States, and although it may have been over-capitalised, his organisation has withstood the test of time, and must be considered eminently successful. American industries in general are fairly well organised, and some are particularly well organised. This applies especially to the oil business, harvesting machinery, coal mining, copper mining and smelting, electrical manufacturing, and locomotive building.

Lord Claud Hamilton some time ago stated that a saving of several millions sterling would result if all the privately-owned wagons on English railways were transferred to the railway companies. The idea could be carried further, and much greater economy obtained by having one company own or at least operate all the railways in the country. This is the day of big business, but it can only become an accomplished fact through the conquest of an army of small details. The war should be accepted by the industrial interests of Great Britain as the most welcome, although unexpected, opportunity thoroughly to reorganise, for if it had not come, Germany would have obtained complete control of all industries in a few years. It is a remarkable thing that German business men were unable to prevent their Government from starting a conflagration, which must mean ruination to many of them, regardless of whether their country wins or loses, providing their competitors, and more especially their British competitors, are willing to accept the golden opportunity.

The Japanese glycerine industry has attained remarkable developments since the outbreak of the war, says the *Chemical Trade Journal*. The Government is now granting pecuniary aid to those engaged in the industry, and the result has been the establishment of the Japan Glycerine Manufacturing Company and several other concerns. Before the war none of these companies existed, and consumers in Japan relied entirely upon imports from the United States and other countries. The output of the Japan Glycerine Manufacturing Company alone amounts to 300 tons a month, and in the course of the next few years the imports of this commodity will, it is believed, be nearly stopped.

NAVAL POWER-BOAT CONSTRUCTION IN AMERICA.

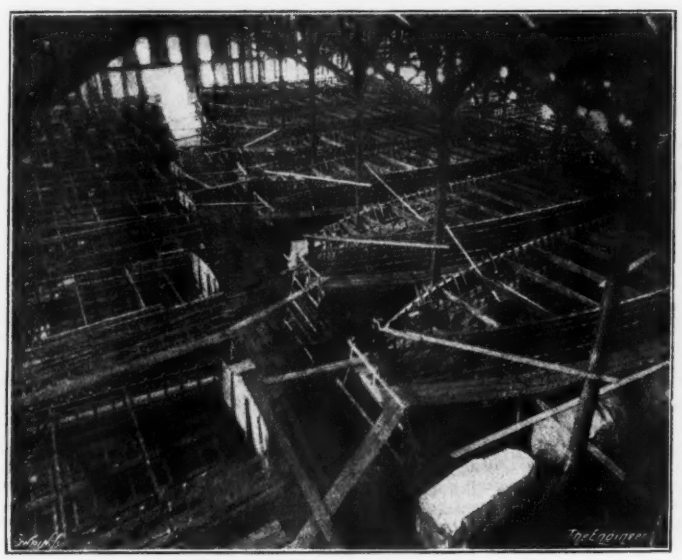
It is generally admitted that the solution of the shipping problem, arising out of the submarine menace, depends to a great extent on the rapid output of vessels built to standard design. This system is already in operation in the shipyards of this country and the United States. The advantages of standardisation in every branch of industry are too obvious to need specifying, though in normal times circumstances do not often admit of its application, especially as regards shipbuilding. In the present emergency, however, prompt delivery is the main consideration, to which everything else has to be subordinated. The astonishing results that can be obtained from a carefully organised system of standardisation are set forth by Mr. Henry R. Sutphen in a recent issue of "Sea Power," an American naval publication. Mr. Sutphen is vice-president of the Electric Launch Company, a concern which has built a large number of fast power-boats to the order of the British Admiralty, for use against enemy submarines. His article throws new and instructive light on American manufacturing methods, and goes far to justify the confidence felt in this country as to the valuable help which the United States will render in restoring the cargo tonnage at the disposal of the Allies to the level required. Mr. Sutphen explains that for many years before the war his firm had been engaged in power-boat construction on the duplication principle, and had also had experience in building mine-laying yawls and launches for the use of the United States Navy and Army. In February, 1915, while discussing with an agent of the British Government the submarine peril, which was then coming to be recognised as a really serious danger, he suggested the use of a flotilla of small, speedy power-boats to be employed in hunting down and destroying the enemy submarines. Two distinct types were submitted. "The first would have an overall length of about 50ft., and would be fitted with high-speed motors; such a boat would show a maximum of 25 knots. The alternative would be something around 80ft. in length, with slow-turning engines, and a speed of 19 knots. I added that my own preference was for the larger and slower type." The delivery of fifty such boats in a year's time was guaranteed. When this offer was made the Electric Launch Company was turning out about six boats a year of the general dimensions indicated, in addition to smaller work; so that, when a few days later the contract for fifty patrol boats to be delivered within a year was duly signed, it became necessary to devise a plan whereby the previous rate of production could be multiplied at least eight-fold. "And the secret," writes Mr. Sutphen, "was in one word—standardisation."



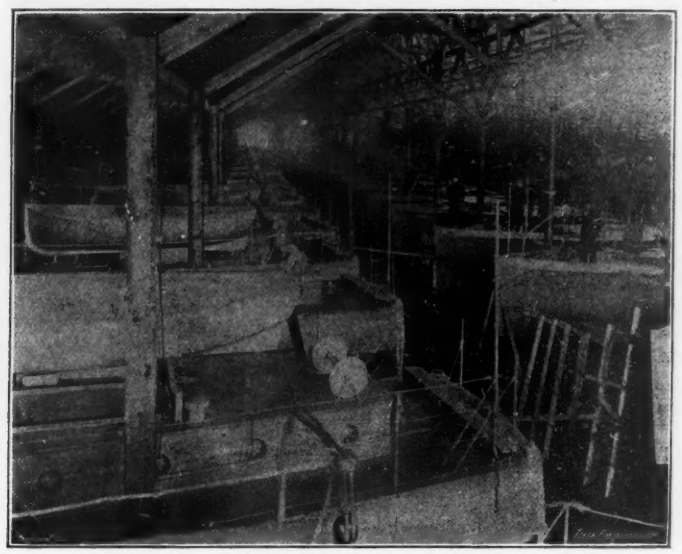
SUBMARINE CHASER ON TRIAL IN THE ST. LAWRENCE

The contract for the fifty boats was signed on April 9th, 1915. By May 1st the master or pattern boat was in frame at the company's yard at Bayonne, New Jersey. In order to avoid clashing with the neutrality laws then in force, it was necessary to seek some working base beyond the borders of the United States; and as Canada was conveniently near, a site was chosen in the neighbourhood of Quebec, where a plentiful supply of labour was assured. Barely had the initial arrangements been made when a cablegram was received from England, ordering five hundred additional boats. This was shortly after the sinking of the Lusitania. The task now before the Company was "to build five hundred and fifty of these boats, and deliver them in complete running order by November 15th, 1916. Taking out Sundays, this would give an actual working schedule of four hundred and eighty-eight days." The new contract was signed on July 9th, 1915, and steps were at once taken to enlarge the existing building facilities. The original base at Quebec was extended, and a second yard released at Montreal. Mr. Sutphen and his colleagues did not forget that standardisation had its drawbacks as well as its advantages, and that the smallest error committed in the designing stage would have been magnified five hundred and fifty times. The supply of material for the work presented some difficulty, but a sufficient quantity of white oak was found in West Virginia, while the mills in the South, having lost most of the export trade through the war, were glad to accept contracts for yellow pine of the highest grade. The amount of detail to be considered in placing these contracts was very great; for instance, the length of the closed freight cars into which the timber would have to be loaded imposed a limit of 42ft. on the length of the planks. Metal parts, such as bronze struts for holding shafts, quadrants, and rudders, were contracted out to firms which had not previously executed work of this description, as the usual sources of supply were not available owing to pressure of domestic orders.

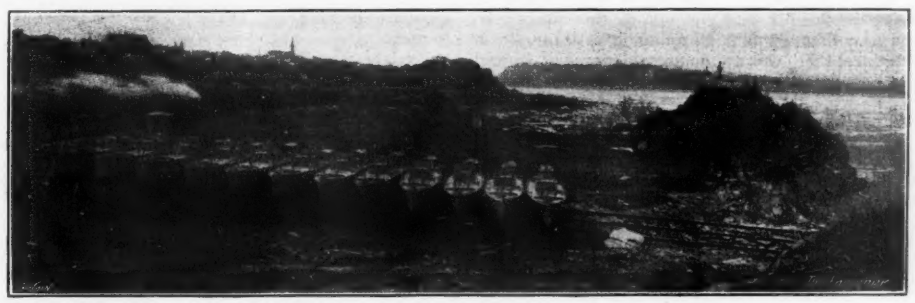
The whole of the material was worked into shape and made ready for assembling at the Bayonne establishment. It was then shipped to the company's yards in Canada to be assembled and fitted up. In consequence of this arrangement due regard had to be paid to the dimensions of the bridges, tunnels, &c., on the railway lines of the United States and Canada. In all, about three thousand truck loads were despatched from Bayonne to Quebec and Montreal. It speedily became evident that drastic innovations would be necessary in the process of manufacture if the boats were to be delivered in contract time. Delicate operations, such as the bevelling and hollowing of the planking and the grooving of the caulking seams, which are usually performed by hand, took more time than could be spared, so special machines were designed to do the work. "The big job," says Mr. Sutphen, "was the making of templates, moulds, and patterns for the first or master boat. After we had these right, the rest was merely a matter of duplication. Everything had to be fabricated in Bayonne, and it had to be absolutely correct in every particular. The men at Montreal and Quebec, who put the boats together, were only ordinary wood-workers, with hardly a boat-builder among them; moreover, only 3 per cent. could speak English. And yet, under the direction of our experts, they did the final work of assembling with ease and despatch. No cutting, shaping, or fitting, of any kind was necessary, for everything was made to exact pattern, and fitted in like the dissected locomotive of our childhood days. Only there was no puzzle in the process, for every separate piece was lettered and numbered. At Bayonne elaborate production charts were kept,



FIFTY BOATS BUILT IN ONE SHED



COMPLETED CHASERS BEING INSPECTED

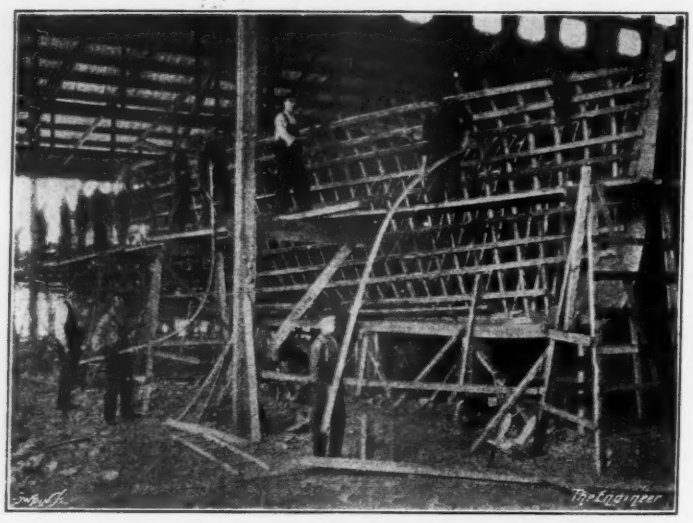


ROW OF SUBMARINE CHASERS READY FOR LAUNCHING

showing at a glance the progress of the manufacturing. Thus, we prevented shortages in one direction and surpluses in another."

The contract, it will be remembered, called for the delivery of five hundred 80ft. power-boats, engined with twin motors, each motor to develop 220 horse-power, and every boat to be completely equipped for service. The contract speed, to be maintained for a full hour's run, was 19 knots, and a mean of 15 knots for four hours. Fuel consumption was not to exceed a stated figure. Between April 9th, 1915, when work was started, and November 15th, 1916, the entire fleet of 550 craft had to be delivered complete in every respect. The period embraced only 488 working days, so that the daily output was considerably over one boat. "This," says Mr. Sutphen, "was the task we undertook to accomplish, and that we did accomplish with something to spare. For the original order of fifty boats was cleared up in November, 1915, four months ahead of time, and the whole lot were delivered by November 1st, 1916, giving us a whole fortnight's leeway. The total number of working days—Sundays being eliminated—was therefore 473, and the mathematically-inclined reader may figure out for himself how much better than 'one boat a day' we had to do. There were times, indeed, when three boats a day were going into the water."

The terms of the contract stipulated delivery of the boats in the St. Lawrence River, and as many as possible were needed before the river became blocked with ice. The first fifty were handed over in advance of the ice, but after this all navigation ceased. To overcome the difficulty it was suggested by the Admiralty supervisors that complete boats might be despatched by rail to Halifax, Nova Scotia, which is an ice free port, where they could be put through their trials during the winter months. The company



ASSEMBLING THE FRAMEWORK OF A CHASER

assented to this proposal provided that the railway could handle the complete boat. To test the matter a skeleton model of the type was built, loaded on to a car used for carrying timber, and sent over the one-thousand mile route between Quebec and Halifax. It was accompanied by traffic experts, who noted every difficulty encountered, and suggested how it could be overcome. Thanks to the co-operation of the railway authorities the overland route ceased to present any difficulty, and henceforth the delivery of the boats proceeded without interruption. The new arrangement necessitated modifications in the assembly shops. "Standard gauge tracks were laid so that the flat-cars could stand directly under the stocks. The keel blocks were set high to clear the cars, and when the boat was ready it could be lowered directly on the flat and run out to the siding. By Christmas, 1915, we were shipping eight or nine boats a week, and there was not a single accident or, indeed, any noteworthy delay. On their arrival at Halifax the boats were at once put overboard, given their trial trip, and loaded for transhipment to England. In all, eighty-four boats were sent over the rail route, shipments being discontinued in the latter part of February, 1915."

The experience gained during the winter months in the manufacturing process, the shipment of parts, and the assembly of boats, proved exceedingly valuable when spring arrived, for a very large number of craft had now to go afloat if the contract conditions were to be fulfilled. In spite of the rapid increasing rate of production no hitch occurred, and by the end of May, 1916, two hundred boats had been handed over, besides a large quantity of spare parts and accessories. "In one sense," Mr. Sutphen observes, "quantity production may be called a monotonous process—'parrot work'—as it has been dubbed. But in another way it is fascinating; it reminds one of the progress of the army, the several units all marching in perfect order to make up one irresistible whole; the very magnitude of the job produces an overwhelming impression of forces and energy. At Montreal there were forty sets of stocks, and at Quebec there were eighty, all in continuous operation. We also used the Duke of Connaught Dry Dock at Montreal for assembly work during the winter 1915-16. This dock is 1000ft. long and 125ft. wide, and it had to be roofed over to protect the work and workmen from the elements. Thirty boats were put together here, and in the spring the dock was lowered and the whole lot floated at once, probably a record launching of its kind."

In view of the criticisms to which this particular class of naval auxiliary has been exposed, owing to its alleged lack of seaworthiness and its failure to make the designed speed, it is interesting to learn that the acceptance trials were extremely stringent. Each boat was tested over a measured distance to ascertain speed, fuel consumption, and general behaviour, while from each batch of twenty-five one was selected to undergo specially prolonged and rigorous trials. With fuel tanks full, and carrying weights equivalent to the complete active service outfit, the selected boat was required to maintain an average of 19 knots for one hour, the trial displacement being thirty-two tons. This was followed by an endurance test of four hours, the contract demanding an average of 15 knots, and providing severe penalties for any excess of fuel consumption beyond the specified limit. As a matter of fact, every one of the two hundred and fifty boats not only bettered its guaranteed speed, but made it at a lower rate of fuel consumption than the contract allowed. It is important to remember that the fitting-out and trials of the boats were conducted under the continuous supervision of inspectors appointed by the British Admiralty, the high standard of quality demanded by which is proverbial. When the trials were satisfactorily completed formal delivery was made. This consisted of signing the inventory book and taking over the many keys for lockers, cupboards, switchboards, &c., comprised in the equipment of each boat, after which the little craft were towed to basins in readiness for the transports which were to convey them across the Atlantic. The five hundred and fifty boats, together with all the necessary spare parts and accessories, were brought to England by one hundred and thirty steamers, every one of which arrived here safely—a significant commentary on the effectiveness of the submarine "blockade," which the Germans claimed to be in full force.

As to the behaviour of these little vessels and the part they have played in suppressing the submarine nuisance, little can be said at the present moment, but it is permissible to add that they have done good service. According to Mr. Sutphen they frequently remain at sea for three or four days at a spell, cruising one hundred miles from land, often in heavy weather, and their low visibility, with their speed and handiness, have made them formidable opponents of the submarine. Boats of a larger type might have given better results, but it was thought more desirable to keep to moderate dimensions in order to facilitate not only the building, but the transport of the completed boats, which otherwise would have proved a most difficult matter. In any case, the achievement of the company in question is one to be proud of, and, as we remarked at the beginning of this article, it serves to indicate the methods which the American shipbuilding industry as a whole may adopt in order to increase their normal productive capacity with a view to meeting the present insistent demand for tonnage.

5-TON ELECTRIC GOLIATH CRANES.

Several five-ton, three motor, electric goliath cranes have recently been supplied to a munitions works in France by the firm of Sir William Arrol and Co., Limited. One of these cranes is shown in the illustrations on page 142. They have been designed for the following working speeds when carrying the full load of 5 tons :—

Hoisting	6.1 metres, say 20ft. per minute.
Traversing	30.0 „ „ 98ft. 6in. per minute.
Travelling	70.0 „ „ 230ft. per minute.

The structure consists of two cross girders carried on steel trestles or legs. The girders are of the lattice type, built up of mild steel plates and sections braced and riveted together. A rail is riveted to the top flange of each girder to form a track for the crab. The legs are built up of rolled steel sections, and they are connected to the girders by large gusset plates. The span from centre to centre of the runway rails is 12.5 m., say, 41ft., and the height from rail level to the underside of the girders is 8 m., say, 26ft. 3in.

The crane travels on four double-flanged cast steel wheels, bushed with gun-metal, and mounted on steel axles. Two wheels, one at each end of the crane, are provided with spur rims, and are driven by the travelling motor through spur and bevel reduction gearing. The motor is mounted in the centre of the span, and transmits its power by horizontal and vertical shafts running in gun-metal bushed bearings. An automatic electric brake is fitted to the motor spindle.

The crab, the frame of which is built up of rolled steel sections and plates, is mounted on four double flanged steel wheels, keyed on to steel axles running in gun-metal bushed bearings. One of the axles is driven by the cross traverse motor through three reductions of steel spur gearing. The load is lifted on four parts of plough steel wire rope winding, two parts being taken on to a cast iron barrel rotated by the hoisting motor through three reductions of steel spur gearing. The barrel is turned and grooved to take the full amount of rope at a single lap.

The load is controlled by two automatic brakes. The first—an automatic electric brake—is fitted to the motor spindle and is operated by means of a solenoid magnet connected in such a manner that the brake is released directly the motor is started, and is applied directly the current is cut off or fails for any reason. The brake is of the post type, so as not to bring any bending action to bear on the motor spindle. The brake straps are of forged steel, and they are furnished with iron brake blocks lined with ferodo.

A mechanical brake of the friction disc type is also fitted. It, too, is automatic in its action, and it is large enough to control the load, when lowering, without undue heating.

The motors, which are wound for direct current at 500 volts, are of the totally enclosed reversing type, specially designed for crane service. Their sizes are :—Hoisting, 10 brake horse-power; traversing, 2 brake horse-power; travelling, 20 brake horse-power; and the speed of all of them is about 600 revolutions per minute. The controllers are of the drum-reversing type.

The driver's cabin is, as will be observed, situated in an elevated position on one of the legs. The switchboard in it consists of an enamelled slate panel having the following mountings :—A double pole main circuit breaker with overload and no volt release; single pole relays for the travelling motor, the traversing motor and for the hoisting motor; one pilot lamp; one plug and socket with portable lamp and length of flexible cable with switches and fuses for the lamps. The fittings are all enclosed in metal cases. The hoisting motion is fitted with a limit switch to prevent overwinding.

Several electro-magnets were supplied with the crane illustrated. That shown in the engraving is 48in. in diameter, and Messrs. Arrol inform us that the approximate weights of material lifted with it are as follows :—

Pig iron	15–20 cwt.
Light scrap	10–16 „
Shafting, bars, billets, rails, and girders	2½–3 tons

For this crane, too, there have been supplied two 24in. magnets with cross bars and slings for carrying the magnets at 6ft. centres. These magnets are used for handling bars 26ft. long, and they lift from seven to twelve bars at a time.

BOOKS RECEIVED.

Critique des Propulseurs. By Paul Popovatz. Paris: Gauthier-Villars et Cie., Quai des Grands-Augustins, 55. 1917. Price 5f.

United States Department of the Interior—Bureau of Mines. Monthly Statements of the Coal Mine Fatalities in the United States during January, February, and March, 1917: Technical Paper No. 106, "Asphyxiation from Blast-furnace Gas," by Frederick H. Willcox; Technical Paper No. 150, "Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air," by George Burrell and Alfred W. Ganger; Bulletin No. 124 (Mineral Technology 17), "Sandstone Quarrying in the United States," by Oliver Bowles. Technical Paper No. 140, "The Primary Volatile Products of the Carbonisation of Coal," by Guy B. Taylor and Horace C. Porter; Technical Paper No. 143, "The Ores of Copper, Lead, Gold, and Silver," by Charles H. Fulton; Technical Paper No. 153, "Occurrence and Mitigation of Injurious Dusts in Steel Works," by J. A. Watkins; Technical Paper No. 166 (Petroleum Technology 39), "Motor Gasoline: Properties, Laboratory Methods of Testing, and Practical Specifications," by E. W. Dean; Bulletin No. 147 (Law Serial 10), "Abstracts of Current Decisions on Mines and Mining," by J. W. Thompson. Washington: The Government Printing Office. 1917.

Before and at the time of the outbreak of the war the number of foreign vessels entering Japanese ports exceeded that of the ships flying the Japanese flag. Now the percentage of Japanese vessels entering these ports is eighty.

A simple method of filling up cracks in the water jackets of motor-car engines, which is often adopted in France, says a writer in the *Autocar*, consists in making use of a liquid solution in which advantage is taken of the property possessed by copper salts to deposit their metallic contents when in contact with iron. To fill up a crack in a water jacket, all that is necessary is to fix the cylinder vertically in a bath or tank; plug up the lower water outlet in the jacket with a cork; then fill the jacket through the upper inlet with a sufficiently concentrated solution of sulphate of copper, which will at once commence to leak away through the crack or cracks and collect in the bath. The liquid should be scooped up as it collects and re-poured into the water jacket; the leakage will be quickly reduced to a slight "weeping" at the crack. When this weeping period has been reached, stop up the upper inlet with a cork in which a bicycle tire valve has been fitted, and by means of a tire inflater force air into the jacket. At first the degree of weeping will increase, but it will gradually disappear and become almost colourless instead of a bluey tint, the repair of the crack then being completed.

RAILWAY MATTERS.

THE Parliamentary Secretary to the War-office stated last week that it was considered that soldiers stationed in this country should not, as a rule, be granted leave, other than draft leave, if it involves travelling by train.

AN American contemporary states that it is officially reported that the most acceptable locomotive in Peru is that manufactured in the United States, not only because of the excellency, construction, and material of the American machine, but because its mechanism is understood by Peruvian drivers and machinists.

THE London and North-Western Railway Company has made arrangements whereby cut flowers for the hospitals are received at the entrance to No. 4 platform, London-road Station, Manchester, between 8.15 and 9.30 every Monday and Friday morning. The blooms are then collected and are in the hospitals by 10.15.

THE Indian Railway Board has appointed a Central Traffic Controller to deal with the question of the relative importance of different classes of traffic, and to control the distribution of rolling-stock between the various systems. The officer appointed is Lieut.-Colonel H. A. Cameron, the traffic manager of the North-Western Railway of India.

THE New York, New Haven and Hartford Railroad has taken off 199 passenger trains, thereby saving each week 2054 tons of coal. There has not been the same withdrawal of passenger trains in the Western States as in the Eastern. Officers of the Western railroads say that they are prepared to take off trains as soon as the movement of troops and military supplies reaches the volume that makes such a step necessary.

PRACTICALLY all the interim dividends have now been declared, and in only two cases are there any changes as compared with the first half of 1916. The Hull and Barnsley pays 2 per cent., as against 1½ per cent., and the Cork and Bandon 1 per cent., as compared with nil a year ago. The former company's advance is due to payment by the Government of interest on capital for the new docks now earning to the benefit of the Government control, whilst the Cork and Bandon had a passenger train accident in the first half of 1916.

THE President of the Board of Trade was recently asked in the House whether there had been any increase of goods traffic on the railways since the Government took over control, notwithstanding the depleted plant; and could he give any comparative figures of 1913 and 1914, and of 1915, 1916, and 1917 of the goods traffic on British railways. To this question Mr. G. Roberts replied that there had unquestionably been a very considerable increase of goods traffic on British railways since the Government took control, but he was not in a position to furnish figures, inasmuch as large quantities of naval and military traffic had been carried on which no charges were recorded.

RAILWAY employees, as a class, are not to be exempt from conscription into the United States National Army. There are, practically, no exemption by classes provided in the regulations issued by the President. Certain exceptions are named in the law—such as Government officers, ministers of religion, students of divinity, persons in military and naval service, subjects of Germany, and other resident aliens who have not taken out their first papers of naturalisation. Exemptions may also be given to persons employed in the transmission of mails, workmen engaged in the arsenals and navy yards, pilots and mariners employed in sea service, &c. The Government takes the position that the percentage of men selected from any one industry will be so small as not to interfere with the operation of any industry.

A VERY remarkable trolley accident recently occurred in New Zealand on the Otira Railway tunnel, in course of construction. Four men on a trolley entered the tunnel, which has a down gradient of 1 in 33. After the party had travelled a short distance their acetylene light was extinguished, and in the darkness the trolley got out of control, and acquired a great speed. Two of the men managed to jump off before the trolley gathered way, but the two who remained were threatened with certain death. The pumps in the tunnel, however, were not working, and the end formed a "pocket" filled with water. This acted as a buffer when the trolley dashed into it. The two men were thrown into the water, where they remained shoulder deep for some time. Darkness rendered their rescue difficult, but it was safely accomplished. They were much exhausted, but unhurt.

THE financial statement of the Canadian Minister of Railways shows that the Intercolonial Railway made a profit of 1,137,713 dols. during the last fiscal year, whilst the National Transcontinental had a loss of 1,966,626 dols. The results from the former would have been better but for the fact that during four months the road was engaged in carrying important munitions traffic and had to put an embargo on many kinds of traffic which paid higher rates. This fact accounted for the net receipts being 180,000 dols. less than in the preceding year. The loss on the Transcontinental compares with a deficit of 652,141 dols. for the year before, and it is stated to be "due to the comparatively small amount of traffic offering; to the fact that trains not warranted by business had to be established, and to the necessity for maintaining the road at the standard of other Transcontinental lines."

THE agreement between the Railway Executive Committee, acting on behalf of the Government, and the National Union of Railwaymen, as to the conversion of the war bonus into wages has now been made public. It states that such additional wages are to be regarded as a war advance, intended to assist in meeting the increased cost of living, and are to be recognised as due to and dependent on the existence of the abnormal conditions now prevailing in consequence of the war. The agreement is to remain in force during the war, and thereafter shall be subject to three months' notice in writing by either side. There is, however, the important proviso that, if after three months from the date of the present agreement there shall be a substantial change in the abnormal conditions now prevailing it shall be open to either side to demand a revision of the additional wages set out in the agreement.

NOTES AND MEMORANDA.

AN American newspaper, called the *New York Times*, recently dispatched a telegram to itself round the world; the circuit, 28,613 miles in length, was traversed in 16½ minutes, the shortest time on record for an ordinary message.

OF the gas sold in Birmingham in the year ended March last, 80 per cent. was used for heating and power purposes, domestic and industrial. Over 20 per cent. was used for industrial heating processes, and nearly 14 per cent. for motive power.

CANADA is about to build wooden ships. The Imperial Munitions Board has decided upon a standard vessel 250ft. long and 2500 tons deadweight. The machinery is to be of the single screw, triple type or geared turbines of 590 indicated horse-power, with two water-tube boilers.

THE new graving dock at Point Levis, Quebec, will be finished shortly. It will be the largest dry dock in the world, being 1150ft. long, 120ft. wide, and 45ft. deep, making it 10ft. deeper than the next largest at Boston, Mass., and 130ft. longer than the Gladstone dock at Liverpool, which, however, is 1ft. deeper.

AT a recent meeting of the Paris Academy of Sciences, M. Sauger made a communication on the time of fall of a stone to the centre of the earth. The problem is considered, taking into account the variation of the density of the globe with the depth. The time found is 19 min. 15 sec.; on the assumption of a density equal to the mean density the time found is 79 sec. greater.

ACCORDING to the *Frankfurter Zeitung*, the newly manufactured compressed cellulose piping has proved very satisfactory in chemical factories and also in mining works. The new material, it is said, is absolutely non-porous, is considerably lighter than iron, can be worked like wood, and is consequently easily moved and repaired. As cellulose is a bad conductor of heat, it requires no particular protection against heat; it also resists chemical influences better than iron. Cellulose tubes are suitable for conducting hot and cold air, and for corrosive gases which eat into iron conductors very quickly. They are not suitable, however, for steam.

THE attention of the Food Controller has been called to the wastage of food stuffs in some of the ironfoundries. It is the custom for a considerable quantity of flour, either wheaten or rice, to be used to "dust" the moulds before pouring the molten metal. In practice there is required on an average from 1½ lb. to 2 lb. of flour in the working of seventy to eighty moulds per day, the size of moulds or flasks used being 24in. by 12in. For small work, approximately 20 lb. to 30 lb. of flour would be used per ton of castings. An experiment has shown that fine sawdust constitutes an efficient substitute, also that wood dust, such as is produced in finishing wood on sand or glass paper machines, is better than flour—either wheaten or rice.

A DRAFT scheme has been presented by the Director-General of Communications to the Spanish Government of a project to reform the national telephone system. Premising that Spain possesses only one telephone for every 571 of her town populations, while France has one for every 143, England one for every 63, Germany one for every 43, and Denmark one for every 23; and that Spain has one rural office for every 45,000 inhabitants, while Germany has one for every 1500, Denmark one for every 1350, France one for every 2321, and England one for every 3440 inhabitants, the draft scheme proposes to establish telephone offices in the greater number of town and rural communities hitherto unprovided with these services, which now only exist in 108 of the principal cities and towns.

THE result of twelve months' working of electric vehicles for cleansing purposes in Sheffield, considered on a financial basis alone, is eminently satisfactory. Mr. J. A. Priestley read a paper on the subject recently before the Institute of Cleansing Superintendents. He said that five vehicles have been at work for varying periods amounting in the aggregate to the work of practically 3½ vehicles for one year. The saving in the work done by them as compared with horse carts over the whole city amounts to £1050 12s. 6d., capital has been written off to the amount of £292 12s. 6d., and electricity supplied from the destructors represents a further sum of £191 14s. 8d., making a total of £1534 19s. 8d. Put in another way, 3½ vehicles working for one year have cleared off more than the entire initial cost of 1½ vehicles.

WHAT are stated to be probably world's records of efficiency in steam engines are given in an American contemporary, *Power*, by Mr. A. D. Skinner, who claims to have made over 400 tests on thirty "Uniflow" engines, with saturated steam. Tests carried out on a 21in. by 22in. engine, both condensing and non-condensing, without shutting down and without making any changes whatever, the engine automatically adjusting itself to the change of exhaust pressure conditions. The steam pressure was 140 lb. per square inch, and the consumption per indicated horse-power per hour from ¼ to full load, condensing varied only between 13.5 and 13.8 lb. Non-condensing the steam consumption varied between 18.3 and 18.8 lb. A feature of the steam curves of the tests is their flatness. It is stated that the engines were not specially prepared for the trials.

ACCORDING to the American Press a Philadelphia inventor is about to build an aeroplane that will end the war in 60 days. It is to be an armoured "gyroscopic hydro-aero-triplane that will cost £90,000, have an average speed of 350 miles an hour, a cruising radius of 65,000 miles, and can start from a point of departure and visit any city in the world without alighting for supplies. It is to remain stationary over the Krupp works at Essen, and demolish them with a preparation 300 times more powerful than dynamite. At Kiel and Heligoland the German navy and its naval base will be demolished. There will be a storage capacity of 40,500 gallons of gasoline to feed the combined engine horse-power of 28,500. The machine is to be capable of making 500 miles per hour. The driving and lifting power are to be furnished by several four-bladed propellers 60ft. in diameter, with a velocity of 1800 revolutions per minute normal speed and 2800 revolutions per minute when flying at maximum."

MISCELLANEA.

QUEBRACHO, a boiler composition obtained from Argentina, is recommended in the *Electrical Review* for cleaning electric insulators.

CONTRACTS have recently been placed by the United States Army with six firms for motor vehicles of the total value of £6,600,000, leaving another £20,000,000 worth to be purchased. The vehicles are of the 1½-ton to 3-ton patterns.

WE learn from a note in the *Board of Trade Journal* relative to the new water supply project for East London, that the ratepayers of that town have adopted the scheme for taking water from the Buffalo River, as proposed by the consulting engineers.

WHATEVER the causes may be, the *Builder* says, we cannot escape from the conclusion that at the termination of the war, and certainly for a good many years afterwards, building will cost about double what it did in 1912, and we shall have to adjust ourselves to an entirely new set of conditions in dealing with our problems.

THE steam generating plant at one of the great meat-canning factories in Chicago has recently been increased from 12,800 horse-power to 16,800 horse-power capacity. The additional plant consists of eight 500 horse-power Stirling water-tube boilers, which will be worked at a continuous overload to give collectively 7000 horse-power. Chain grate stokers will be used.

THE *Revista Maritima* mentions the submarines as now being constructed without periscopes of the ordinary type. Instead of the usual vertical tube arrangement a system of two lenses, one on either side of the vessel, is being employed. It is claimed that this device is much less visible from a distance, although it has the drawback that the vessel must navigate nearer to the surface.

OWING to the scarcity of steel Canada will not be in a position to build steel ships for at least two or three years. According to Mr. Mark Workman, president of the Dominion Steel Corporation, at Montreal, the Canadian Government Railways, the Canadian Pacific, and the Grand Trunk are all crying out for rails, but nothing can be done to get them. The Corporation is spending this year something like £1,000,000 in extensions and improvements, but the increased output is all provided for in contracts already made.

A CORRESPONDENT of the *Scientific American* makes the suggestion that the best way to combat the U-boat is to net the North Sea. He suggests that the nets be composed of 10ft. lengths of chain, with a snap hook in each end, and 3in. links. These nets would be assembled on board ship and would form a continuous net from shore to shore. About 3,760,000 lengths of chain would be required to form a net 250 miles long by 150ft. deep. The mines should also snap in between the mesh, to keep them in position. Damaged links would be easily replaced with new in very short time.

A CALL to American seafaring men, on behalf of the Merchant Marine, has been issued by the National Government through the United States Shipping Board. The Government wants the services of every man now free to enrol who can qualify as a watch officer or has a fundamental knowledge of engines or engine-room duties. It will need in a few months 10,000 officers for the large fleet of cargo ships to be constructed for the Shipping Board. These ships are to form the nucleus of a new, nationalised fleet that eventually will carry the flag to every quarter of the globe.

IN its issue of July 29th *Le Journal Officiel* published the text of a Law, promulgated on July 27th, authorising improvement works on the Seine in the region of Paris, having for their object the prevention of floods and the improvement of navigation. These works comprise (1) the widening of the left arm of the Seine, known as La Monnaie, at Paris; and (2) the deepening of the bed of the river as far as Bougival. The total cost of these improvements is placed at 67,346,000 francs, part of which is to be borne by the City of Paris and the Department of the Seine. Details of this scheme were given in our issue of July 6th.

AT the instance of British representatives the Chinese Government has issued circular instructions to the provincial authorities with regard to the frequent complaints received concerning the imitation of foreign trademarks by Chinese. The local authorities are directed to issue warning proclamations on the subject and to make more active efforts to suppress the practice. A memorandum prepared by the British Legation enumerates eighteen cases of infringement reported to it since 1912, and indicates the action taken. Most of the articles concerned are commodities, the manufacture of which has begun on a considerable scale in China.

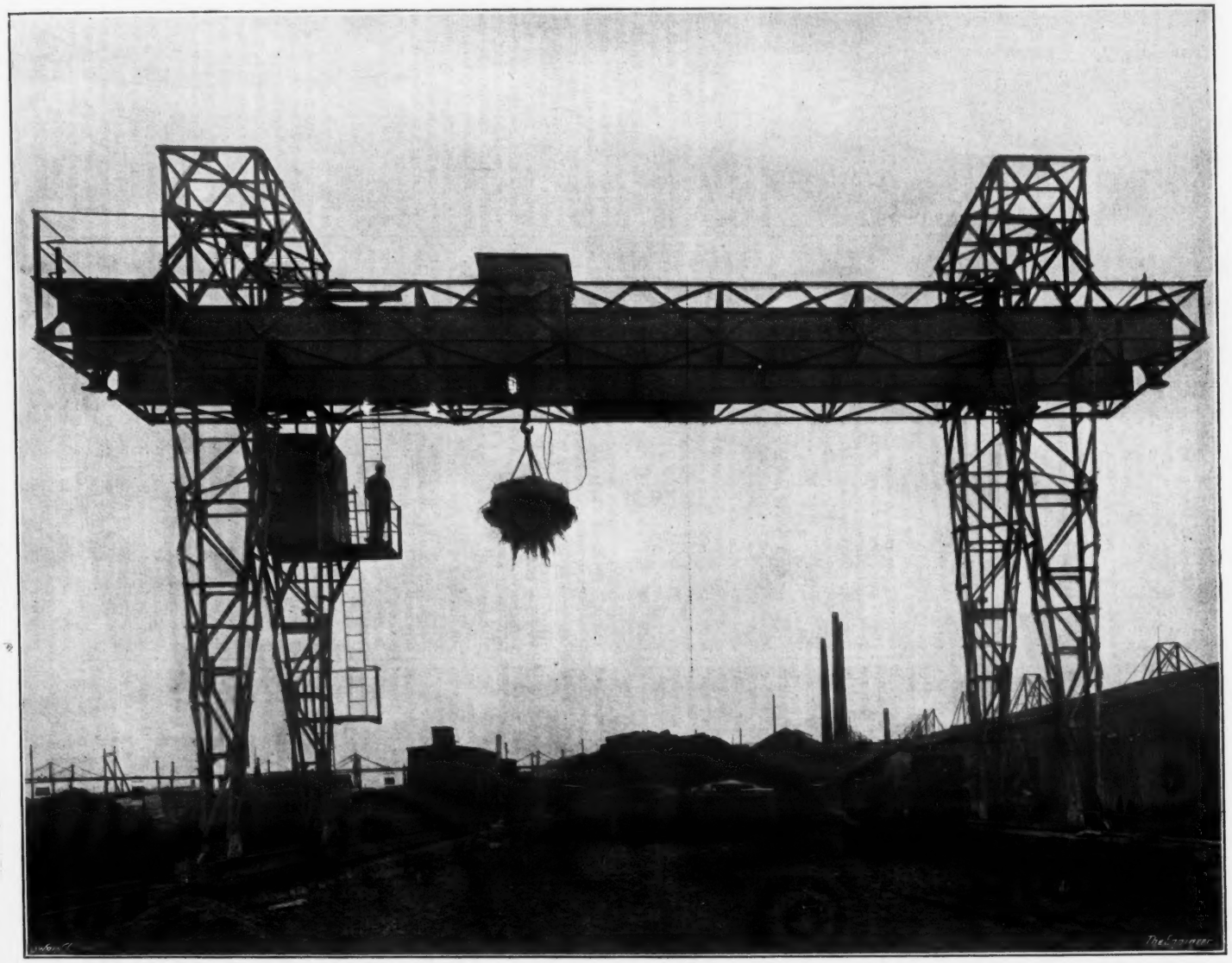
ALTHOUGH electricity is rapidly displacing other forms of power in this country for driving machinery, we are still behind the Americans, who seem to have applied it to driving cattle. It is reported that an electrically charged rod for this purpose is being introduced upon some of the ranches of Western Texas. It is said to be specially suited for making rebellious cattle enter dipping vats, branding pens, and other enclosures into which it is ordinarily a difficult matter to drive them. The rod is constructed with four dry cells and a coil, and is equipped with a button by which the current may be turned on when it is desired to apply it to an animal.

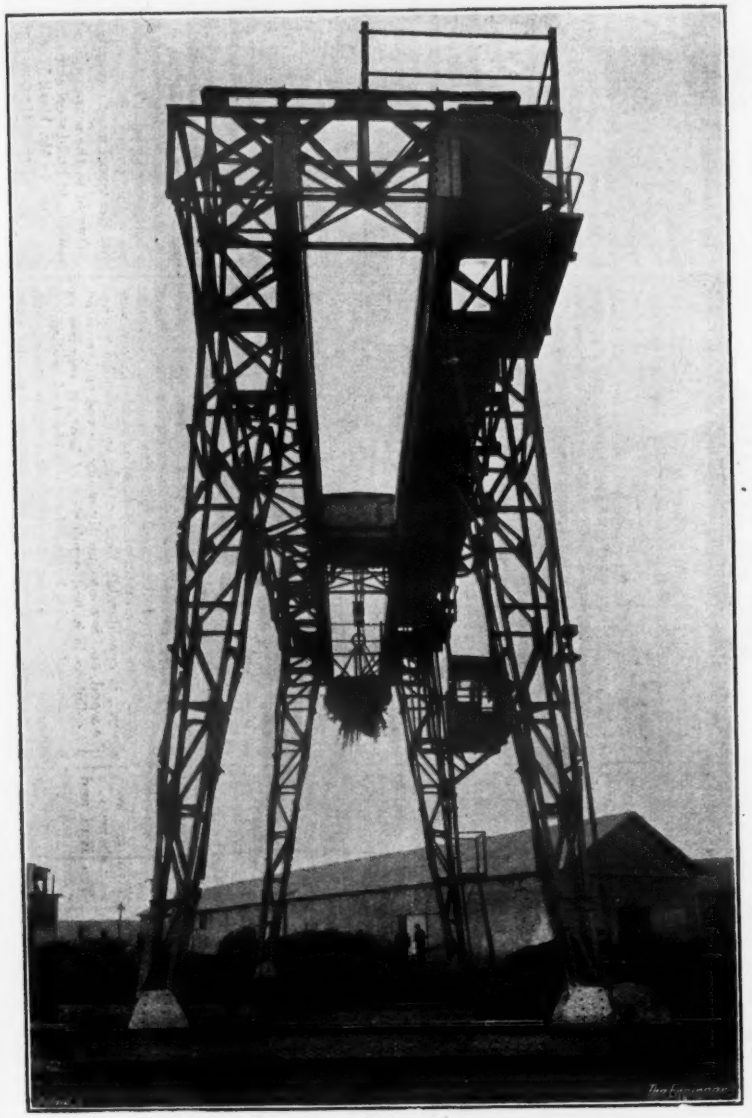
IN the issue for July 19th of the *Board of Trade Journal* reference was made to the projected manufacture in New South Wales of steel wheels, &c. The same journal, in its issue of August 9th, states that the Sydney Office of H.M. Trade Commissioner in Australia now reports that the company undertaking this enterprise has been registered in Sydney under the title of Commonwealth Steel Products, Limited, with a nominal capital of £250,000, of which permission to use £100,000 immediately has been granted. The company intends to erect modern workshops and plant at Newcastle for the manufacture of railway wheels and axles, roll spring steel, steel castings, and other similar products. Supplies of steel will be obtained from steel works in the vicinity. It is anticipated that the company will commence operations in about eighteen months.

FIVE-TON ELECTRIC GOLIATH CRANES FOR FRANCE

SIR WILLIAM ARROL AND CO., LIMITED, GLASGOW, ENGINEERS

(*For description see page* 140)





Agents Abroad for the Sale of The Engineer.

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, LIMITED, Shanghai and Hong-Kong.
TIENTSIN PRESS, LIMITED, Tientsin, North China.
EGYPT.—F. DEIMER, FINCK AND BEYLANDER, Shepheard's-buildings, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT & CIE., Rue Dauphine, 30, Paris.
INDIA.—A. J. COMBRIDGE AND CO., Bombay; THACKER AND CO., LIMITED, Bombay.
THACKER, SPINK AND CO., Calcutta.
ITALY.—LOESCHER AND CO., 307, Corso, Rome; FRATELLI TREVES, Corso Umberto, 1.174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan; Libreria, DETKEN AND ROCHOLL, Naples.
JAPAN.—KELLY AND WALSH, LIMITED, Yokohama.
MARUZEN Co., Tokyo and Yokohama.
RUSSIA.—C. RICKER, 4, Nevsky Prospect, Petrograd.
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TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

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THE ENGINEER.

AUGUST 17, 1917.

Our Naval Strategy.

FOR several months past a lively correspondence has been going on in *The Times* and other journals on the subject of our naval policy generally, and North Sea strategy in particular. Many retired naval officers have contributed to the discussion, as also has Mr. Winston Churchill, who as a former First Lord of the Admiralty is entitled to an attentive hearing. In some circles, it appears, a feeling prevails that the Navy is not being handled with the boldness and energy demanded by the situation. The critics ask why our naval forces, with all their incomparable resources in men, ships, and guns, do not take the offensive and attempt to get at the enemy and, above all, why no attempt is made to strike at the root of the submarine evil by sealing up or destroying the raiders in their lair? The management of naval operations, say the critics, is in the hands of certain officers who are constitutionally averse to taking risks, and who, therefore, impose a veto on any and every plan of aggressive action which aims at seeking out the enemy instead of placidly awaiting his good pleasure. The prolonged controversy to which we have alluded has tended to cloud the fundamental issue, which is simply this: Is it possible for the Navy to undertake, with a reasonable prospect of success commensurate with the hazards involved, a great offensive against the coast strongholds of the enemy, with the purpose of destroying his battle fleet and putting an end to the submarine *guerre de course* by barricading every channel through which the U-boats enter or leave? The fact that no attempt has been made in this direction indicates that in the judgment of the Admiralty an operation of this character is not feasible. It may, therefore, be worth while to set forth the principal considerations which have, doubtless, led the Admiralty to decide against a naval offensive.

Irrespective of attack by air, there are two methods by which the naval bases of Germany might be assailed—namely, by naval bombardment alone, or by a fleet attack in conjunction with a military landing. Of the results likely to attend the first method we had an example at the Dardanelles. Those impatient people who urge the Navy to "take the offensive" are loth to admit a parallel between the conditions which ruled at the Dardanelles and those which would be encountered in the event of a grand scale attack on the German coast. In this they are prudent; for if the difficulties that foiled the naval attempt to force the Dardanelles were multiplied tenfold, we should gain some idea of the task that would confront the Fleet in a similar enterprise against, say, Wilhelmshaven or Cuxhaven. The Allied Fleet at Gallipoli had to deal with shore defences that were partly obsolete and partly improvised. Of the many big guns mounted, only a small percentage were of modern pattern. The majority of the garrison, it is understood, were Turks, with a sprinkling of German artillerists in charge of the more important technical posts. Ammunition for the guns was none too plentiful, and there was a scarcity of the mines and torpedoes on which reliance was mainly placed for barring the Channel to the Allies' ships. Yet the great attempt to force the passage on March 18th, 1915, broke down with losses which, heavy as they were, came within an ace of being much more serious. In spite of a vast expenditure of ammunition by the ships, the principal defences ashore suffered negligible damage, only the exterior forts of Kum Kale and Sedul-Bahr being laid in ruins. The batteries commanding the Narrows suffered hardly at all, though in an effort to silence them the British and French battleships had braved the minefields and engaged the enemy under a cross-fire at almost point-blank range. On that historic day the handling of the Allied Fleet was a marvel of audacity and determination. But the task that had been set was an impossible one, and the meagre results obtained cost the Allies three battleships, to say nothing of serious damage to other units of the squadron. The defences which guard the German North Sea Coast are admitted to be exceptionally strong. Millions of money and infinite labour were spent on them during the ten years previous to the war. They literally bristle with guns of maximum range and power, mounted in emplacements of armour and concrete which are proof against the heaviest bombardment, and in most cases the battery positions are so cunningly hidden as to be quite invisible from the sea. They are manned by the "Matrosen-Artillerie," a highly trained corps which specialises in the working of heavy coast guns. Furthermore, there are formidable auxiliary defences in the form of mine-fields, shore torpedo stations, and destroyer and submarine flotillas assigned for the protection of each base. Nor is it only these elaborate artificial defences which make the German seaboard so difficult to approach. The coast itself is infested with shoals and sandbanks to an extent that renders navigation extremely difficult even in normal times. In war, with lights extinguished and booms and buoys removed, only consummate seamanship and a generous measure of luck could save large vessels from disaster in these treacherous waters. To make any impression at all on the strongholds where enemy submarines find refuge the attacking fleet would have to consist of powerful modern ships, armed with the heaviest long-range guns. A "scratch" squadron such as that which assembled at the Dardanelles would be worse than useless. Old ships are consequently ruled out, for their guns would be hopelessly outranged by the 45 and 50-calibre high-velocity pieces which are known to be mounted in the German shore batteries, and their protection is inadequate to withstand gunfire of this description. This debars our pre-Dreadnought "surplus fleet," which the advocates of an offensive policy are so eager to sacrifice. As for the new monitors, they are useful enough in certain operations, but we venture to doubt whether their designers ever intended them to be employed against defences as formidable as those which protect every vulnerable point on the German coast. In any case, the limited number of heavy guns they carry prevents them from maintaining that volume of fire which is absolutely essential to the success of an operation such as we are discussing. It seems, then, that to be effective the bombarding force would have to be made up of super-Dreadnoughts—in other words, the Grand Fleet would have to yield up some of its very finest ships. We leave it to the critics of the Admiralty to decide whether or not it would be sound policy to deprive the Grand Fleet of some of its most powerful units at a time when the enemy's battle squadrons, of whose exact strength we have no certain information, are still intact. If, after negotiating the mine-fields and escaping the torpedoes launched by submarines and destroyers, the attacking force got within range of, say, Cuxhaven, and completely silenced the outer batteries—a most improbable contingency—how could it follow up its advantage? The locks of the Kiel Canal would be a tempting objective, but unfortunately they are situated seventeen miles higher up the river Elbe, and the channel, which can be navigated by deep-draught ships only on a flood tide, is commanded at several points by further powerful batteries, and, in addition, would undoubtedly be mined. Probably, therefore, the fleet would have to withdraw after silencing the outer forts, and in a week or less the enemy would have thrown up new defences quite strong enough to keep ships at a respectful distance. And Cuxhaven, be it remembered, is only one of many bases, each of which would have to be dealt with if the object was to blockade the submarines. Many people seem to think that the activity of the raiders would practically cease if Ostend and Zeebrugge were sealed up, but we fear this is a delusion. To reach the Atlantic and the Channel they would simply go "north about" Scotland, as, in fact, many of them have done from the beginning. Stated in terms of hard fact, the "naval offensive" of which so much is heard becomes a singularly unattractive proposition, which would inevitably lead to severe losses, with no prospect of solid gains to balance them. *Un canon à terre vaut un vaisseau à la mer* is an axiom that applies with special force to-day. That there is scope for improvement in the measures now being taken to cope with submarine piracy may be true, and it is possible also that opportunities have been lost of dealing the enemy shrewd blows by sea and air. But it is quite another matter to censure the Admiralty for its reluctance to split the Grand Fleet and squander men and ships on an enterprise which, we are convinced, would be condemned as impracticable by an overwhelming majority of the officers who are now serving afloat.

This somewhat clamant agitation for a naval offen-

sive is, moreover, to be deprecated for reasons other than those we have cited. It is based on the assumption that the naval policy we have followed during the last three years has been more or less without decisive effect on the issue of the war as a whole. We fail to understand how anyone cognisant of the facts can arrive at such a conclusion. The tremendous influence of sea power has never been displayed more convincingly than in the present struggle. It is sea power alone which has enabled the Allies to keep in the field with steadily growing strength, to bring the resources of the whole world under contribution, and to amass those vast reserves of men and material which must ultimately place the military supremacy of the Allies beyond dispute. It is sea power, again, which is remorselessly sapping the vitality of the Central Empires and reducing them to economic impotence. Faulty as some allege it to have been, the naval blockade has proved wonderfully efficacious in fostering war weariness in Germany and Austria and diminishing their powers of endurance. We have, in truth, derived such incalculable benefit from our mastery of the waters as to make the influence of sea power on the wars of the past seem insignificant in comparison. The demand for a naval offensive—in other words, for a course of action which must inevitably jeopardise our supremacy—is strangely ill-timed at a moment when, owing to the intervention of the United States, the Allies are in a position to make the blockade far more stringent than was hitherto possible. Germany asks nothing better than that we should send our warships against her impregnable coast defences, and she still clings desperately to the hope that irresponsible agitation in this country will eventually compel the naval authorities to depart from the sound policy they have pursued up to now. We are confident that she will be disappointed. We note with satisfaction that Sir Eric Geddes has expressly disclaimed any intention of interfering with the strategical operations of the Fleet and will follow the example of his predecessor in leaving these matters entirely in the hands of his professional advisers. That they are very capable hands will, we think, be admitted by most people after an impartial review of the naval history of the last three years.

Organisation and Efficiency.

With a growing hope that if we cannot yet see the end, the final phase of the war is now being reached, it is natural that more and more attention should be given to the industrial outlook. The discussions which have taken place on this subject recently have been prolific of criticism, both destructive and suggestive, and of prophecy, sometimes of disaster to our manufacturers, but frequently as to the high place which Great Britain is destined to occupy in the new industrial era. There are some who profess to believe that the manufacturing and commercial supremacy this nation formerly enjoyed has been surrendered for all time; that lack of organisation, the relations between capital and labour, and want of co-operation have so undermined our industrial efficiency that the lost ground can never be regained. These are the opinions, not merely of certain outside critics, but of some of the pessimists in our midst. It is a happy sign that these forebodings of industrial disaster are not too widely held at home, or very generally believed abroad. The majority of our own manufacturers, as well as the more intelligent class of workers, while realising the defects of our old system, believe that the experience of war working has shown how these defects may be remedied, and some of our trade competitors, both enemy and neutral nations, are convinced that Great Britain will emerge from the world war, in the winning of which our engineering industries have played so important a part, better equipped than ever before for the commercial campaign which must follow the clash of arms on the battlefields of Europe and Asia. The measure of the fear of our industrial rivals as to the results of the new spirit which has been instilled into our manufacturing system is the measure of the increase in British industrial efficiency arising out of the lessons of the war. We believe that if our people have read these lessons aright, and there are many signs that they have, there is good ground for the belief that Great Britain will come out of the conflict stronger and more self-reliant than she has been since those pioneer days when her industrial supremacy was not merely freely acknowledged, but was almost unchallenged.

The fault with many of the critics is, that their eyes are so closely riveted on the obvious shortcomings of our manufacturing system, that they fail to realise the inherent strength and vitality of the industries which, in face of these handicaps, have accomplished so much. Take the case of the writer to whose views on the industrial outlook we give currency in to-day's issue of The Engineer. Armed with a practical knowledge of engineering and manufacturing in the United States, as well as in Great Britain and one of the Overseas Dominions, he finds British industry almost deficient in many of the factors which count in the sum of efficiency, both in manufacturing and transport, upon which the prosperity of this country depends. This critic—to whose opinion we are glad to give publicity—seizes upon that blessed word "organisation," and traces the suggested failure of Great Britain to keep pace with other manufacturing nations to the want of it in our industrial system. He lays special stress on the lack of financial organisation, which he clearly regards as one of the root causes of the failure to keep our place in foreign trade. The catalogue of contributory factors is a long one: want of education, attitude of the trade unions, out-of-date factory system and equipment, lack of standardisation in design of staple products, failure to realise the economic benefits of large scale production, and the elimination of internal competition by the creation of manufacturing combinations, as well as failure to obtain the necessary co-operation between capital and labour. There are other clauses, but these are the main items of the indictment of British engineering, and the writer's contentions are supported by illustrations of the practice which now obtains in such industries as electrical engineering, locomotive construction, and shipbuilding. In an endeavour to prove his case up to the hilt, he seizes upon the value of the output per person as an index to efficiency, and shows that the value of the products of British workers is only from one-third to one-half that of American workers in the same branches of industry. He dismisses the obvious reply, that higher selling prices may explain this significant fact by references to particular examples, and assigns the chief reason for the higher value of the output of the American worker to the more extensive use of machinery and the consequent higher individual power. Some of our industries, it is asserted, would be benefited by complete reorganisation, and all of them by drastic measures of reform. British commercial methods, as well as the manufacturing system, are the object of attack. There is, it is said, too much individualism in the selling department as well as in the factory, no organisation for maintaining those close and uninterrupted relations with consumers comparable to that of which other nations have made a feature. In two words, the British manufacturing system is just casual, and its commercial representation haphazard, and we have paid and shall continue to pay the penalty for placing dependance on methods so out of date. These are the main charges, not all of them new and some of them very familiar, which are laid against British industry by a critic who, having, it would seem, the interests of the old country very near his heart, is yet constrained to paint a picture of our industrial position in such sombre hues. He believes, however, that the war has provided Great Britain with an opportunity for the reorganisation without which she is, it would seem, destined to a still further recession in the order of industrial precedence.

It is as well, perhaps, that publicity should be given to these opinions, as our contributor has only written what many others think. We ourselves are very far from saying that all is well with British industry, but we do assert that the average critic overstates his case and fails to give credit for assets on the other side. The British manufacturer is probably as keen on the subject of organisation as the most advanced system-ridden American manufacturer, but it must be organisation of a type suited to the particular manufacturing activities of Great Britain and not of the United States, which has built up its industries mainly on the demands of a large and protected home market, whereas Great Britain has been compelled by geographical and economic conditions to go out into the markets of the world. Nor can it be denied that in spite of all the talk about the defects of our methods—and there are many—we have over a long period transacted an uncommonly good foreign trade and created a diversity factor for it which has provided insurance against the temporary failure of particular markets. In truth, a good answer to the critic is to be found in the trade returns, which make a brave display for the nation of incompetents we are sometimes held to be. Doubtless, there is much in the manufacturing system of Great Britain which is in need of reform, but the mistake of our detractors is, that they magnify mistakes in auxiliary matters into inherent defects. At its core British industry is sound. If there is one characteristic which is valuable, both as an individual and national quality, it is that of adaptability, and the needs of the war have shown that the British manufacturer and worker possess it in supreme degree. We may have been indolent and indifferent to the old threat of industrial competition, but the way in which engineering has responded to the war call shows that, whatever its surface deficiencies, at bottom it is a collective industry capable of an effort which has astounded the world. Beside this achievement, the reforms necessary to enable the British industry to compete effectively in home and foreign markets is an easy feat. Indeed, many of the reforms to the need for which attention has been directed—improved facilities for industrial education, standardisation of product, formation of manufacturing combinations, improved machinery equipment, joint representation in foreign markets, financial aid to industry, the co-operation of labour and capital, are not only receiving serious consideration, but are, in some instances, accomplished facts. The standardisation of ship construction and marine engine design, the earnest endeavour to make an alliance between capital and labour, and the tendency to form manufacturing combines, are illustrations of what is being done. We are as alive as the critics to our defects, but more conversant with the character of our particular needs. The reform movement now in progress will be based neither on the American nor on the German system, although it may take something from each, but will be governed by the special conditions under which our industry and commerce are conducted.

CITY AND SUBURBAN ELECTRIC RAILWAYS OF SYDNEY.

The problem of the railway and tramway communication of Sydney, New South Wales, with its surrounding suburbs, is of great interest, in view of the many years of argument and controversy dating from the earliest introduction of railways in New South Wales in the later fifties.

Meantime, the completion of the system has been complicated by the construction of electric tramways, which have hitherto been sufficient to fill the gap to some extent, but quite inadequate later, for the purpose.

The estimate for the new electric railways and tramways, which have been authorised and already put in hand, is 20 millions sterling, an expenditure which is probably unequalled for works of this kind when compared with any other city in the world of its size. This is, exclusive of the purchase of land and buildings, a costly feature.

The Central Railway Station, curiously so termed, for it is situated on the southern outskirts of the city, has a few branches leading from it, but there is also a main arterial outlet at the northern end of Sydney leading across the harbour, necessitating a high-level bridge 1600ft. in main span, one of the principal features of the scheme, and another one nearly equal in dimensions crossing an inlet of the same harbour.

A report by Mr. J. J. C. Bradfield, M. Inst. C.E., chief engineer of the proposed electric railways, written subsequently to his tour, embracing Europe and America, contains an exhaustive description. Embodying this with information from other sources, we shall first describe the general features of the main Sydney Harbour Bridge, ranking, as it will, as the third largest in the world.

The structure will consist of nickel steel cantilevers, supporting centre girders, also of nickel steel. The anchor or shore arms of the cantilevers are to be each 500ft. long, the harbour or cantilever arms each 520ft. long, and the centre girders 560ft. long. The main piers supporting the cantilevers will be placed 1600ft. apart, centre to centre, and the total length of the steel work will be 2600ft. Provision is made between the main girders for four lines of electric railway and a roadway 35ft. wide. Outside the main girders on the eastern side there will be a motor car roadway, 18ft. wide, between hand-rails, and on the western a footway 15ft. wide. The central 560ft. of the bridge will be level, with gradients of 1 in 39 on either side, the headway for this portion being 170ft. above high water, with not less than 156ft. over the whole fairway

The cantilevers will rest on cast-steel bearings, which in turn will be seated on pyramids of rolled steel joists and concrete to distribute the weight equally over the tops of the piers; the pyramids will rest on rock, free of the span. The wind pressure on the central span will be transferred to the cantilever arms by a pin connection and sliding cross-head to allow for expansion movements. Sway or transverse bracing will be provided between all vertical members of the bridge for rigidity. The trusses of the centre of the suspended span will be 100ft. deep between centres of chords, the chords being parallel, and the depth of the cantilevers at the towers will be 70ft. between chord centres. The web systems will be of the Warren type throughout, all main members being inclined. The panels will be subdivided, and there will be minor supporting and stiffening members. The contour of the cantilever arms on the upper chord will be parabolic, with a horizontal tangent at the ends adjoining the suspended span, and that of the anchor arms will be a circular arc,

the tangent to which, at the end of the span, is not horizontal. These two curves are chosen arbitrarily to fit in with panel lengths and avoid objectionable slopes to some of the stiffening members. Eyebars will be used for tension chord members, which will therefore be much lighter than if built of plates and shapes, owing to loss of efficiency at the riveted joints and lower unit stresses allowed for built members. Eyebars will also be easier to erect than built-up members, particularly near the towers. Except for the main cross girders, the floor systems are to be constructed of carbon steel.

The railway tracks are to be carried on three stringers throughout the bridge. On the stringers will be placed an intermediate system of floor beams, and on the latter will rest built troughs carrying the rails, which will be fastened to longitudinal wooden sleepers inside the troughs. The upper flanges of the troughs will be braced at appropriate intervals, and there will be a general covering of ¼in. steel plate over the whole floor. The flooring of the main roadway will consist of wood blocks, or rock asphalt, carried on coke concrete, having a minimum thickness of 3in. above the buckle plates. The buckle plates, ⅜in. thick, will be carried on 15in. by 5in. rolled joists placed on longitudinal plate girder stringers. The motor car roadway is designed for lighter motor traffic, and will have a wearing surface of 1in. of rock asphalt, carried on coke concrete with buckle plates, as in the main roadway. The footway also will have buckle plate flooring, with a wearing surface of 1in. of rock asphalt, there being a filling

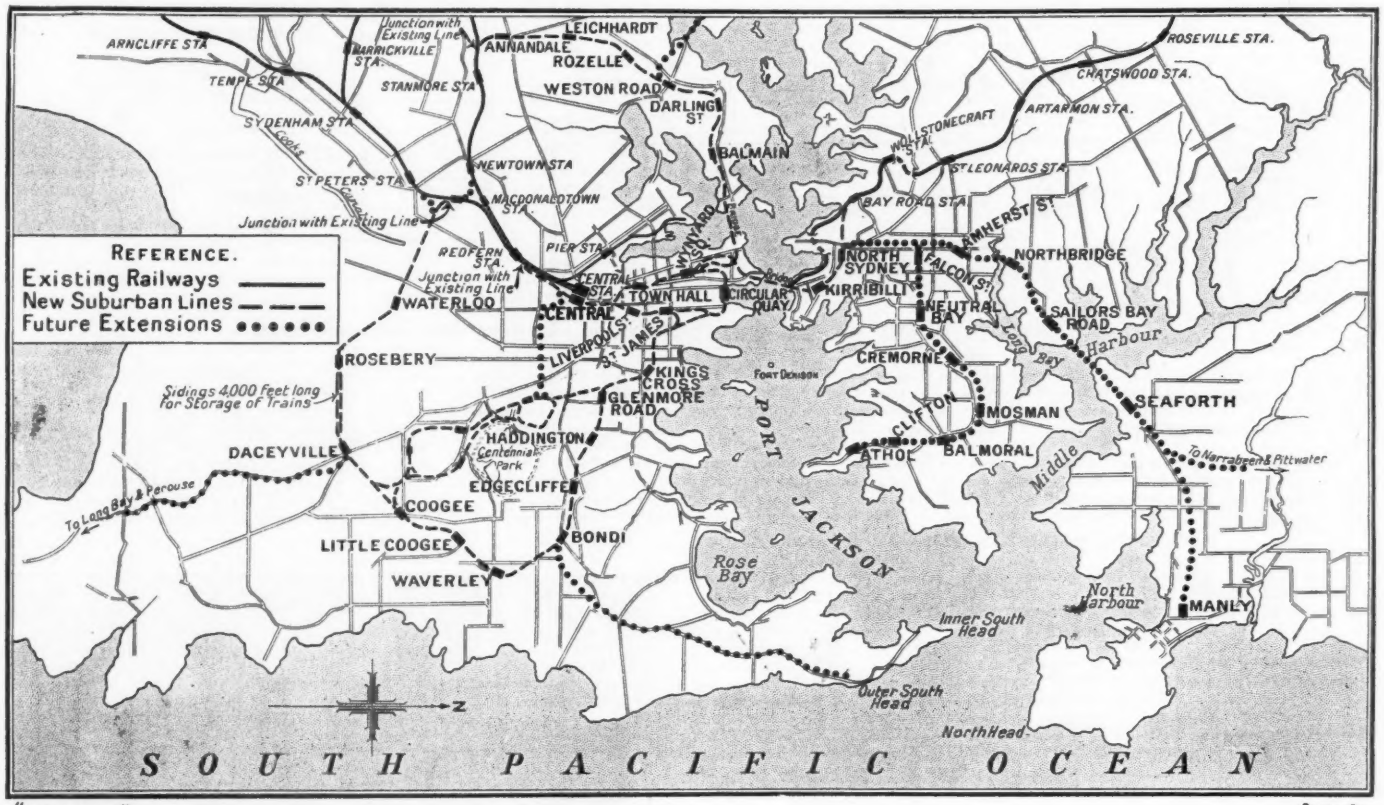
terminus from the south end, the lines will leave in a northerly direction and pass underground on a gradient of 1 in 40, the substratum being sandstone rock. The track will then divide ; three will traverse the western side of the city, and three the eastern side, meeting at the wharves at Circular Quay, and forming a three-track underground loop railway with six stations in all—Central, Town Hall, Wynyard-square, Circular Quay, St. James, and Liverpool-street. From the Central Station trains will proceed citywards by the outer and inner tracks of the western branch and by the central track of the eastern branch.

The ruling gradient will be 1 in 40, against the traffic, and 1 in 30 with the traffic, and these gradients will render it possible to have fly-over junctions at all crossings except at the connecting loop at Liverpool-street.

The minimum curve will be of eight chains radius. At the stations the platforms will be 520ft. long, and there will be two for each track, one for arrival and the other for departure ; passengers will enter the carriages on one side and leave on the other, so that ingoing and outgoing traffic will be kept separate between the street and the trains. The width of the side platforms will be not less than 12ft., and of the island platforms 24ft.; they will either be straight or constructed on curves of large radius. At the Town Hall Station, which is typical of the smaller stations, the platform will be about 28ft. below street level, and access will be given by stairs in two flights, with a level walk between the flights. Wynyard

double track, and for that for holiday traffic is 7 miles 32 chains. The ruling grade is 1 in 40, and the sharpest curve is 8 chains radius. Island platforms 520ft. long will be provided at the stations, and these will be so arranged that the suburban tramways will act as feeders to the railway.

As regards the western suburbs, a double-track loop railway also shown on the plan, joins up with the City Railway on the south side of Wynyard Station, thence in a north-westerly direction in cut and cover as far as Agar-street. Here the tracks curve to the east and continue under the Fort-street school grounds and the eastern side of the Observatory Park, emerging at the northern boundary of that park. The railway is then carried on viaduct across Watson-road, Argyle-street, and Argyle-place, where it is joined by the roadway and footway approaches of the proposed bridge across Darling Harbour. Continuing on viaduct in a westerly direction, the line passes over Kent-street, Hickson-road, and Bettington-street, and from thence across Darling Harbour to Balmain by means of a high-level cantilever bridge, 1350ft. centre span, providing for two lines of railway, a 35ft. roadway, an 18ft. motor roadway, and a 15ft. footway, the bridge to have a minimum headway of 170ft. above high water. On the Balmain approach the railway, roadways, and footways continue on viaduct until the two latter reach the natural surface at Darling-street, near Adolphus-lane. From the bridge the line passes, as shown by the map, through various streets and roads, including stations, to join the main line with a fly-over junction between Stanmore



"THE ENGINEER" SWAIN Sc.

THE EXISTING AND PROPOSED SUBURBAN RAILWAYS OF SYDNEY

of coke concrete level with the top of the buckle plates. The kerbs of the main and motor roadways will consist of steel plates and sections ; the hand-rails will also be of steel, and will be latticed with 1¾in. by ¼in. bars.

Before the decision was made to construct the bridge across the harbour, the alternative method of traversing the channel by a tunnel was proposed, and the plans were prepared accordingly. But two objections were made to this. One was climatic, in effect that the addition of an underground metropolitan railway, with its stuffy atmosphere, to a scheme which, on the whole, was laid in generally sunny surroundings, was undesirable. The other objection was a mechanical one, indicated by Mr. David Hay, M. Inst. C.E., of Messrs. Mott and Hay, Westminster, who was instructed to visit the locality and to report generally on the subject. He was of the opinion, owing to natural features, the ground rising rapidly, especially on the north side, that a very great loss of level would be incurred, and, moreover, the distance to be traversed by the tunnel would be greater than by the bridge. This additional loss would add at least 15 per cent. to the cost of the electric current alone on the haulage of every ton taken over the line. This would amount to a very large sum of money, taking into account the heavy suburban and other traffic—estimated at 50 trains per hour—over the interval in question. The head room under the bridge above the maximum high-water level is to be 170ft.

As to the city railway, proceeding from its present

square, the most important of the underground stations, will be on two levels, the trains from North Sydney and Balmain coming in at the high level platforms, and the city railway traffic at the low level platforms. Between these platforms there will be a concourse floor, access to which will be given by three entrances with easy approaches.

An overhead direct-current high-tension system is contemplated, and automatic electric signalling will be installed throughout. The line will have to accommodate the ordinary rolling stock of the State, which is of 4ft. 8½in. gauge, and as carriages, 72ft. long and 10ft. 6in. wide, will have to pass through the tunnels, it will be of unusual width. The permanent way will consist of 100 lb. steel rails on hardwood sleepers, bedded on ballast. The total length of single track is rather more than 16 miles 52 chains, of which 7¾ miles is above ground, and 8¾ miles underground.

As shown by the plan, the eastern suburbs double-track railway connects with the City Railway between Circular Quay and St. James' Stations by means of two junctions, and proceeds in an easterly direction in tunnel under the domain to Sir John Young Crescent, where it emerges from the ground and passes, as shown in detail by the map, to a point about 10 chains south of Erskineville Station. The inner circle railway for the holiday traffic to the Show Ground Cricket Ground and Racecourse junctions with the eastern suburbs line near the Glenmore-road Station, and proceeds *vid* the Show Ground, &c., to near Coogee Station. The total length of the line, inclusive of the sidings for storage of trains, is 10 miles 56 chains of

and Petersham Stations. The total length of the Western Suburbs Railway is 5 miles 27 chains of double track. The ruling gradient is 1 in 30, and the sharpest curve is 8 chains radius. All the stations are "open air," with island platforms, each 520ft. long.

The other lines, called the Northern Suburbs Railway, as shown by the plan, make junction with the City Railway south of Wynyard-square Station, and pass underground in a northerly direction to Princes-street, where they emerge and continue in open cutting to Agar-street, thence on embankment to Argyle-place. There the viaduct construction of the Sydney Harbour Bridge approach commences, and carries the railway over Argyle-place to Princes-street, where the railway joins with the roadway and footway approaches on the main bridge, which we have described. Thence the line proceeds to connect with the Milsons Point to Hornsby railway, near the Bay-road Station. The stations have island platforms, 520ft. long. The ruling gradient is 1 in 39, and the sharpest curve 8 chains. The total length of the line is 2 miles 48 chains.

The estimate includes the electrification of the steam railways from the Central Station, *vid* the inner zone, to Parramatta, Hornsby, Sutherland, and Bankstown ; the electrification of the outer zone to Penrith, Campelltown Waterfall, the Hawkesbury River, and the construction of various underground tramways supplementing the ordinary electric tramlines on the surface. These are not wholly covered by the map shown herewith.

FURNACES FOR THE HEAT TREATMENT OF METALS.

For the heat treatment of cast iron fuse and shell parts some special furnaces have been introduced by John Wright and Co., of Essex Works, Aston, Birmingham. These furnaces, which have been expressly designed for the treatment of cast iron parts by the oil bath process so as to prevent rusting, are made in two forms (*a*)—the ordinary, and (*b*) the automatic, and both forms are made in two sizes, the one giving an output of one thousand parts per day of ten hours, and the other of two thousand in the same time.

The smaller sized non-automatic furnace is shown on page 147, and a drawing of the larger size is given in Fig. 2. It will be observed that at the loading end there is a table provided with rollers, on which the wrought iron tray containing the fuse parts is placed. The regenerative oven furnace is 2ft. 6in. deep by 18in. wide and 9in. high. From the unloading platform at the far end, the tray is plunged into an oil tank by means of a dipping frame slung on chains supported by a cantilever attached to the tank, and provided with a counterbalancing arrangement so as to facilitate handling.

The automatic arrangement is shown in Fig. 1. It differs from the non-automatic in that there are two malleable iron traversing chains to carry the parts being treated through the furnace. At the further end the parts are automatically delivered into the oil tank, through which they are carried by another traversing chain. There is also an arrangement by which the parts are automatically delivered either into a cleaning tank, a saw dust bath, or into any other receptacle as may be required. The makers point out that the advantage of the automatic arrangement is that the necessity for experienced or skilled attendance is minimised. The rate of traverse, both in the furnace and in the quenching tank, can be so timed that every part being treated shall spend in the furnace and in the tank respectively the exact time required for producing a perfect result. The oil bath is cooled by the oil being circulated by a pump through pipes arranged in a cooling vessel, the water in which is continually being changed.

The furnaces are built of cast iron, and are lined with fire-brick. Ordinary town gas, at ordinary pressure, is used, and the makers claim that an evenly distributed heat is given by the natural draught burners employed.

This firm has also introduced a series of coke-heated oven furnaces, specially designed, for annealing, hardening, re-heating, and case-hardening and for the heat-treatment of all kinds of metals with economy of time, fuel, and labour. It claims that with this type of furnace high temperatures are quickly attained, and that by reason of the particular construction and methods of regulation these temperatures are easily and evenly maintained. We gather that it is possible to raise the temperature to 950 deg. Cent. with natural draught, and that all the furnaces are fitted with a connection for an air blast, which enables the heat to be raised quickly to 1250 deg. Cent. The air pressure required is from ¼ lb. to 1 lb. When the blast has been used and shut off, a much higher temperature can thereafter be maintained by means of natural draught only than would otherwise be possible. It is further claimed that the construction of these furnaces ensures uniform temperature over the entire oven, so that its whole floor surface is available for heating, and that there is no space wasted.

An example of one of the furnaces is shown in Fig. 3. They are strongly constructed, and being self-contained may be fixed in any position to which a suitable flue may be led, and in any convenient position to the air, when it is intended that forced draught should be used. The interiors, including doors, are lined with furnace brick, and the furnace bottoms have been made of great strength, with a view to permit very heavy work to be dealt with. Doors are provided either at one or both ends of the furnaces, and they may be single or double, according to size; but in the larger sizes lifting doors, supported by counter-balance weights, are supplied. The doors have inspection holes with shutters. To facilitate the handling of material treated a cast iron shelf is fitted at the bottom level of the door opening, and rollers can be also fitted, if desired. Five standard sizes of furnace are made. The smallest is 15in. high by 24in. wide and 36in. deep, and the largest 18in. high by 48in. wide and 72in. deep.

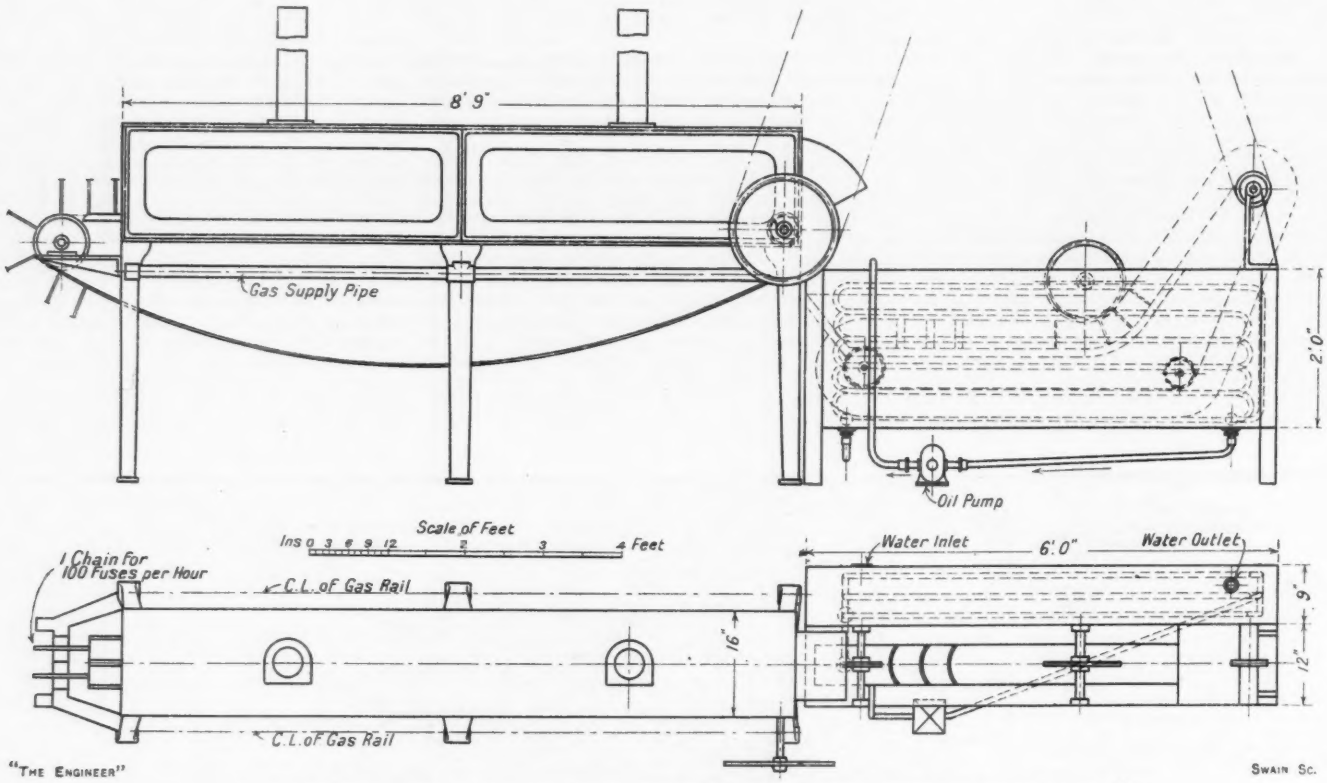


Fig. 1—AUTOMATIC FURNACE FOR THE HEAT TREATMENT OF CAST IRON FUSE AND SHELL PARTS

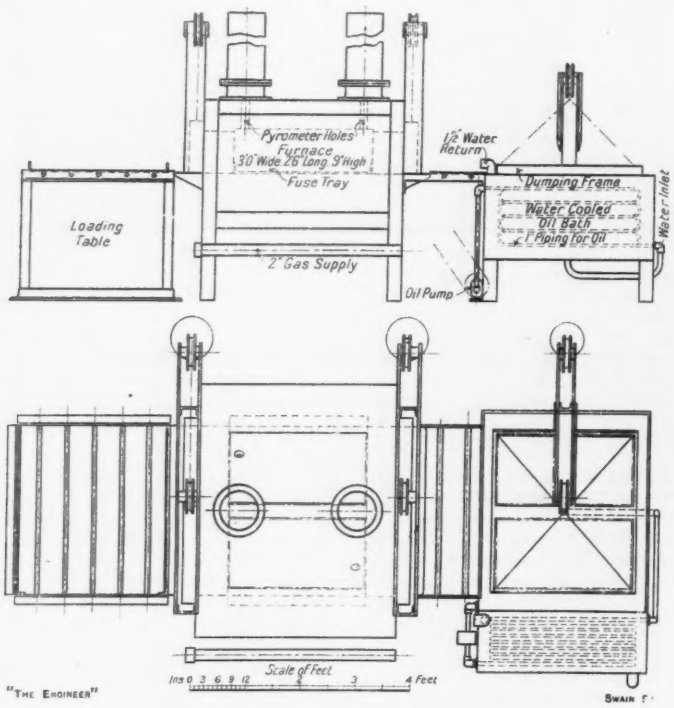


Fig. 2—FURNACE FOR THE HEAT TREATMENT OF CAST IRON PARTS

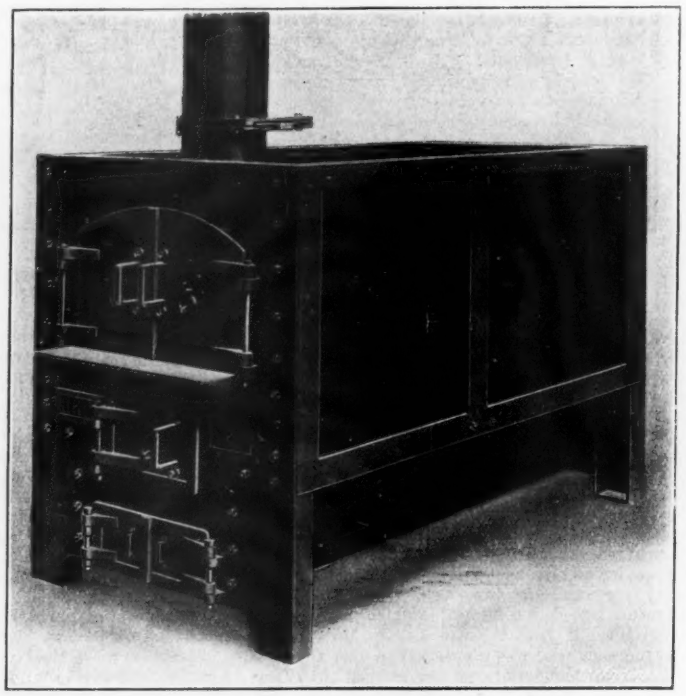
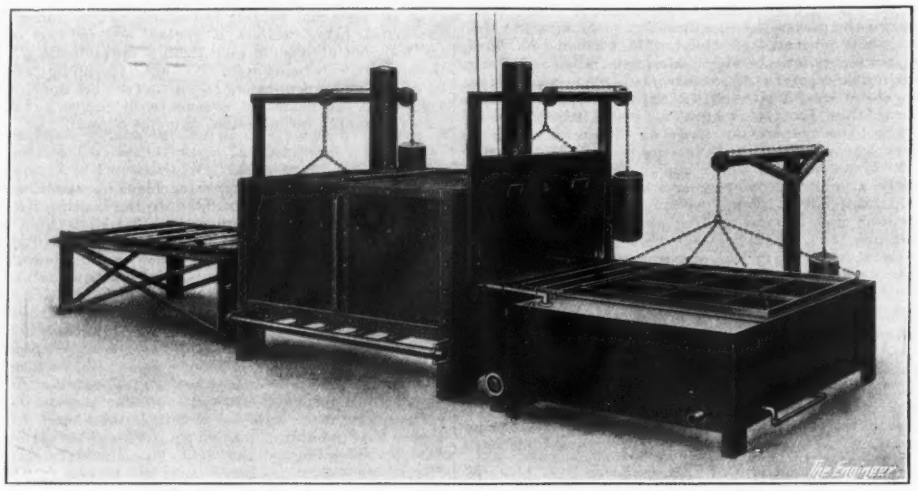


Fig. 3—COKE HEATED OVEN FURNACE

Tea growing is greatly on the increase in Nyasaland. The output during 1915-16 increased by 75 per cent.

FURNACE FOR THE HEAT TREATMENT OF CAST IRON PARTS

JOHN WRIGHT AND CO., ASTON, BIRMINGHAM, ENGINEERS



WELDING WITH APPLICATION TO AUTOMOBILE ENGINEERING.*

By HERBERT L. TOWNS.

(*Concluded from page* 126.)

BLOW-PIPE.

The blow-pipe is an instrument requiring careful consideration and thought from first to last; in the first place the designing, and, lastly, in the handling during operation. The consideration in design being partly to make the instrument absolutely safe in case of careless handling on the part of the welder, and consideration on the part of the welder, partly to allow for bad design. The blow-pipe, if properly designed, built up, and handled, is an instrument of simplicity and safety, being light, compact, and easy to handle. The work to be performed by the blow-pipe, namely, that of mixing the two gases, is of extreme importance, as the obtaining of a good sound weld to a great extent depends on the flame produced at the blow-pipe nozzle, and the flame depends on the mixture of the gases.

In theory, for the total combustion of one volume of acetylene, two and a-half volumes of oxygen are required, but in actual practice the proportion of acetylene to oxygen varies between 1 to 1¼ and 1 to 1¾. The result of a weld obtained by the use of a mixture of gases in incorrect proportions may be of a very unsatisfactory nature, as if a superabundance of oxygen is admitted the flame produced will have oxidising effects, whereas if a superabundance of acetylene is introduced, the flame produced will have a carbonising effect; in which case a hardening of the metal in the immediate vicinity of the weld will result, and the finished work will, consequently, be of a brittle nature. The correct flame for welding is, therefore, the one that is half-way between an oxidising and a carbonising one.

An experienced welder can readily estimate the proportions of the mixture of gases he is using by a glance at the flame produced. Some of the idea of the flames produced by different mixtures is given in Fig. 5. The view on the left hand shows the flame produced by a mixture having an excess of acetylene, and all blow-pipes should be able to produce such a flame by having the oxygen admitted at normal pressure and the acetylene at full pressure, although this flame should not be used. If a blow-pipe is not capable of producing a flame of this description, either it is faulty, or the system for carrying the acetylene from the generator is in some way out of order, causing the passage of the acetylene to be obstructed. When a blow-pipe is producing this type of flame, the acetylene cock on it, or the outlet cock on the safety valve should be partly closed, till a flame similar to that shown in the central view is produced, which is the correct flame to use. The centre white light which appears in the view on the left hand as a somewhat indefinite form has now become smaller and more definite. If a further reduction in the supply of acetylene be made by closing either of the cocks in the acetylene system already mentioned, the centre white light becomes much smaller, as shown in the right-hand view, which is an oxidising flame, produced by a mixture of gases having an excess of oxygen.

There are many different forms of blow-pipes in use, but the general principle is the same in each case, and these vary in length from about 1ft. to 2ft. The blow-pipe, as shown by the outline sketch, Fig. 6, consists of a handle A, through which passes two tubes, B and C, each fitted with a regulating cock D. These tubes carry the gases to a mixing chamber E, from which the mixture is passed to the nozzle F.

In the designing of a blow-pipe an essential point for consideration is the distribution of weight, as the instrument should as nearly as possible balance when held by the operator for ease of manipulation. Blow-pipes are divided into three distinct classes, which are named according to the pressure at which the acetylene is being used, namely:—(1) Low pressure; (2) medium pressure; (3) high pressure. The pressures at which the acetylene is used are approximately:—(1) For low pressure, .1 lb. to .25 lb. per square inch, which is the pressure at which the acetylene is generated; (2) for medium pressure, 1.5 lb. to 5.5 lb. per square inch; (3) for high pressure, 4.5 lb. to 7 lb. per square inch.

High-pressure blow-pipes are not commonly used in practice, in consequence of which blow-pipes are often referred to as being of two classes, high pressure and low pressure, the high-pressure class being what in reality is the medium-pressure class. The real high pressure blow-pipe is only adaptable in cases where dissolved or compressed acetylene is being used, all other forms of acetylene having insufficient pressure for the mixing of the gases. Low-pressure blow-pipes are also uncommon, as far as being used is concerned. In this type of blow-pipe the gases flow at a very low speed, and back-firing is experienced; however, safety devices are usually fitted, which render them safe to handle. The medium-pressure blow-pipe is the type that is most commonly used, and has very few disadvantages. In this type of blow-pipe back-firing is very unlikely, owing to the pressure of the gases which keeps the speed high. The only real danger experienced in the use of the blow-pipe is due to back-firing, and this is provided for by the fitting of safety devices. Attempts have been made to cut out this small piece of the installation, but the results have been far from satisfactory.

The blow-pipe is usually made of brass, and is constructed in such a way that it is impossible for the gases to mix before they reach the welding head or mixing chamber. The nozzle is usually a detachable piece, so that the size of the orifice can be varied to suit the consumption of gases required for different classes of work. Blow-pipes are usually supplied with a series of nozzles which vary according to the consumption of the gases required for the different classes of work to be done. The size of the nozzle is determined by the consumption of acetylene per hour, and the sizes, having a large range, being made to use acetylene at rates varying from 1 to 100 cubic feet per hour. These nozzles are made of copper, which metal withstands the heat much better than other less suitable metals. The size of nozzle suitable for welding various thicknesses of metals may vary slightly according to the make of blow-pipe used, but some idea of the consumption of acetylene can be gathered from Table III. *ante*, and the approximate rate at which the various thicknesses of metals can be welded by using nozzles to give the consumptions shown therein is given in Table IV.

TABLE IV.

Thickness of metals to be welded. Inch.	Approximate run per hour. Feet.
1/32 to 1/20	39
1/20 to 1/16	38
1/16 to 1/12	20
1/12 to 1/8	10
1/8 to 3/16	6
3/16 to 1/4	4
1/4 to 1	3
1 1/4 to 1 1/2	2
1 1/2 to 2	1

Some idea of the variation in costs of welding various thicknesses of metals can be gathered from Tables III. and IV. To take a comparison, say, 1ft. of welding is to be done on a metal having a thickness of one-twentieth of an inch, and also a similar length on a similar metal having a thickness of 2in. In the first case the consumption of oxygen and acetylene is .051 cubic feet and .038 cubic feet respectively, while in the second case the consumption of oxygen and acetylene are 125 cubic feet and 100 cubic feet respectively; hence, the proportion for the costs of the gas alone is as 1 to 2500; on top of this the time taken for the operation is thirty-nine times greater in the second case than in the first case.

It has already been mentioned that the blow-pipe is an instrument of simplicity and easy to handle; but also being an instrument of precision, very great care is called for in the maintenance if a perfect and economical working is to be experienced. The cleaning of the nozzles should be attended to at regular intervals, and great care is required here, as the size and shape of the orifice should not be altered, because any change in this direction will cause more or less serious results when used again. Any increase in the size of the orifice of a nozzle would tend to decrease the velocity of the mixture at the exit, and the tendency to back-fire would be increased. It is therefore advisable, in cleaning a nozzle, to use some instrument which is not harder than the material of which the nozzle is made, and a suggested suitable instrument is a piece of brass wire, which should be run through the opening.

In order to ensure that the interior of the blow-pipe is kept free from any obstruction, the blow-pipe should be disconnected from the feeding tubes, and the nozzle connected up to the oxygen tube; then the opening for feeding oxygen into the instrument should be temporarily closed, and a current of oxygen blown through the acetylene passage. By playing on the end of the acetylene passage finger, a fluctuation in the exhaust of the oxygen is caused, and the clearing of the interior of the blow-pipe is accomplished.

It is advisable to avoid the dismantling of a blow-pipe by any except persons thoroughly experienced in this class of work, as the putting together of the parts requires a certain amount of skill, the accuracy of which governs the correct working of the instrument.

The starting up and stopping of the working of a blow-pipe should be done in a methodical manner, and the following are suggestions for doing this, references being made to Fig. 7, which shows an outline of the apparatus in the vicinity of the operator:—First, the checking of the hydraulic safety valve A for water level should be done, by opening the overflow cock, and re-charged with water, if necessary, and the overflow cock closed. Now, with tap B closed, tap C should be opened, then oxygen valve D should be closed and cylinder opened by means of the key. The adjusting screw should then be adjusted so that the required working pressure is registered by gauge F. Now open tap B, and when the acetylene is smelt at the

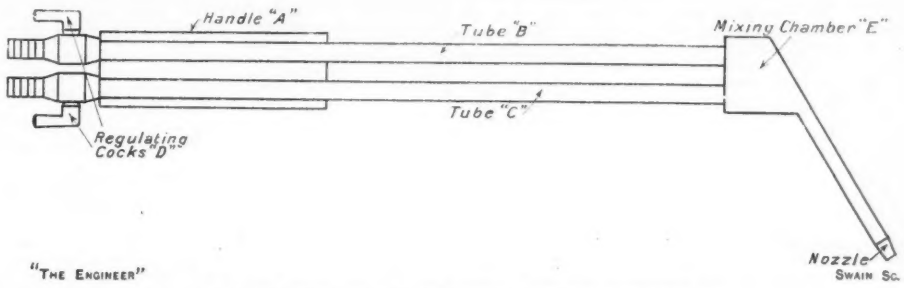


Fig. 6—DIAGRAM OF AN ACETYLENE WELDING BLOW-PIPE

Sketch of Flame produced by a mixture having an excess of Acetylene.
Sketch of Normal Flame.
Sketch of Flame produced by a mixture having an excess of Oxygen.
"THE ENGINEER"
SWAIN SC.

Fig. 5—INCORRECT AND CORRECT ACETYLENE BLOW-PIPE FLAMES

* Paper read before the Graduates Section of the Coventry Branch of the Institution of Automobile Engineers. Abridged.

nozzle, it should be ignited, then tap D should be opened to admit the oxygen to the blow-pipe. It will be necessary to correct the oxygen pressure, which will have dropped, as will be seen by the gauge F, owing to the opening of the tap D. Now, by means of tap B the acetylene

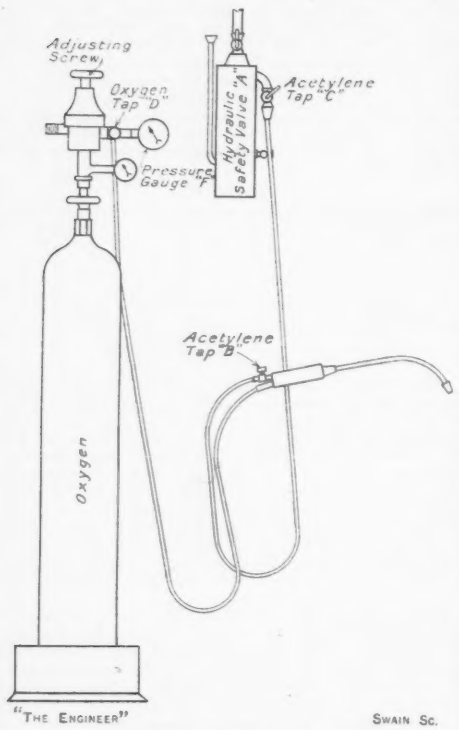


Fig. 7—ACETYLENE WELDING PLANT

should be shut down until the flame is normal, as shown in Fig. 6. On stopping work the acetylene tap C should be closed first, then the oxygen tap D, and in case of work being completely stopped the oxygen cylinder should also be shut off, and the pressure released from the regulator.

In case of a back-fire the tap C should be immediately shut off, and the blow-pipe should not be re-lighted for a few seconds. Before the lighting up of the blow-pipe, in the morning, it may be necessary to disconnect the acetylene pipe from the blow-pipe, in order to drain out any accumulated moisture.

It is very interesting to note the chemical change that takes place by the burning of the mixture of gases at a blow-pipe nozzle. If acetylene is burnt with an equal volume of oxygen the chemical products are hydrogen and carbon monoxide, shown by formula :—$C_2H_2 + O_2 = H_2 + 2CO$, this action taking place in the small white portion of the flame; then these two gases burn in the outer flame, taking oxygen from the air, the chemical action being :—$CO + O = CO_2$ (carbon dioxide), and $H_2 + O = H_2O$ (water vapour).

THE PROPERTIES AND WELDING OF DIFFERENT METALS.

The use of welding instruments is a comparatively simple task, which can be easily acquired by very short tuition or practice; but to become an expert welder is something much more difficult. In order to be able to execute welding in a manner worthy of the term welding, it is necessary for the executant to have some knowledge of the properties of the metals which are to be welded. The knowledge of the properties of metals is useful in the preparation of parts to be welded, and it is often due to the lack of adequate preparation that comparatively simple operations in welding prove to be failures.

The metals commonly used in the engineering industry are the only ones we need consider, these being :—Cast iron, malleable iron, wrought iron, steels, copper, brass, and aluminium.

CAST IRON.

This metal is used to a very great extent in automobile practice, being specially applicable in cases where the brittleness, which is one of the features it possesses, is of no disadvantage, such as :—Engine cylinders, pistons, brackets, and covers of various description.

Good cast iron is very uniform, and has a melting point of about 2400 deg. Fah. A good feature possessed by cast iron is that it is not easily warped by heat. Another point worthy of note is the expansion due to heat; this amounts to .068in. per foot length for every 1000 deg. Fah. by which the temperature of the metal is raised.

MALLEABLE IRON.

This is a form of metal which is obtained by the removal of a quantity of the carbon from cast iron, which results in this metal being of a softer nature than cast iron. In actual practice this metal is not extensively used for automobile work, on account of the lengthy period necessary to produce. The melting point of this metal is in the neighbourhood of 2500 deg. Fah., and after melting it regains the properties of cast iron when cooled down; for this reason it is not advisable to weld malleable iron.

WROUGHT IRON.

This is a metal obtained by the removal of nearly all the impurities from cast iron by special treatment, and is suitable for certain classes of bar work. Like malleable iron, when kept heated for any length of time, wrought iron turns to cast iron. The melting point is at about 2900 deg. Fah., and the expansion due to heat is at the rate of about .078in. per foot length for every 1000 deg. Fah. by which the temperature is raised.

STEELS.

This metal is a combination of iron, with small percentages of carbon and various other substances, which percentages vary according to the class of steel. However, for the purpose of classification, it can be taken that there are three grades of steels—mild, medium, and hard, the melting point of which vary from about 2700 deg. Fah. in the case of mild steel to about 2500 deg. Fah. in the case of hard steel, and the expansion due to heat is about .083in. per foot length for every 1000 deg. Fah. by which the temperature is raised. Steels contain small percentages of phosphorus, varying from a trace, usually up to about .05 per cent.; but in exceptional cases it reaches a higher percentage and has bad effects on the steel, especially when welding. The phosphorus does not exist in steel as free phosphorus, but as iron phosphide, and which is not evenly distributed. After the metal has been melted and is crystallising, the phosphide is concentrated between the crystals, so that when cool it is frequently noticed that cracks develop round about the weld.

IRONS AND STEELS.

In irons and steels there exists varying percentages of carbon, which can burn and cause a burning of the metal. Care should be taken on the part of the welder to avoid this, as the nature of the metal is altered by burning.

COPPER.

This metal is not extensively used in automobile work for welding purposes. It has a melting point of about 1950 deg. Fah., and the expansion due to heat is .106in. per foot length for every 1000 deg. Fah. by which the temperature is raised.

BRASS.

This metal is not frequently welded, but it is of interest to note that the melting point is about 1800 deg. Fah., and the expansion is fairly high, being .115in. per foot length for every 1000 deg. Fah. by which the temperature is raised.

ALUMINIUM.

This is a metal which has found a place among the most popular of metals used in automobile engineering. The melting point is about 1175 deg. Fah., and the expansion due to heat is about .148in. per foot length for every 1000 deg. Fah. by which the temperature is raised. This is one of the most difficult metals to weld, as when being melted it falls away. A special feature about this metal is that when it is melted it forms an oxide known as alumina, which oxide has a melting point that is much higher than aluminium; in fact, about four times as high. Unless this oxide is cleared away a weld cannot be made; hence a suitable flux must be used to destroy the oxide. Aluminium contains certain impurities, such as iron and silicon, which, together with aluminium, forms a brittle and hard alloy. If the impurities are present in a high percentage, say, 1 per cent., the quantity of the alloy formed is sufficient to form a network round the grains of metal. This often causes aluminium welds to fracture; hence it is necessary that this metal should be very pure for welding purposes.

WELDING RODS.

Welding rods are used to replace any metal that has been taken away, either owing to damage or to preparation of the article to be welded. Welding rods should be used, except in cases where very thin metal, say, less than 16 gauge, is being welded. Care should be taken in the use of welding rods that no impurities are introduced into the weld; for instance, the rods should be kept free from dirt or rust. Rods having rust on them are oxidised, and it has already been stated that an oxidised weld is not satisfactory. It is advisable to use welding rods supplied by firms which specialise in the manufacture of this class of goods.

In welding cast iron work, a welding rod of alloy iron should be used, known as silicated cast iron rod. These rods have a fair percentage of silicon in them, which tends to take the brittleness out of a weld by reacting with the carbon in the iron. In welding steels a rod of Swedish iron is almost invariably used, which on account of its purity makes a weld of very even grain and easily machinable. In cases where special classes of steels are being welded, such as "high carbon steel," "nickel steel," &c., rods of special composition should be used; for instance, in high carbon steel, there is the possibility of the carbon burning when the metal is being used, and the welding rod should contain an excess of carbon in order to replace that which is burnt, so that the finished weld will be as nearly as possible similar to the metal being welded. Rods of phosphor-copper are used for adding to welds made in copper, while for brass a rod of brass is used. In the case of these metals being welded in the form of sheets, the welding rod is really in the form of a wire. In welding aluminium a rod of aluminium should be used. These rods are specially alloyed in order to give the necessary even flow of metal.

In all cases the welding rod should not be added until the metal, being welded, is melted, and for this reason the rods are alloyed to give them a lower melting point than the metals being welded, so that the filling rods can be added without allowing the metal to cool down, for if molten metal comes in contact with cooler metal the result is simply an adhesion, and not a weld.

FLUXES.

Flux is used in welding as a cleansing agent, and is usually in the form of a powder. In the melting of metals it often happens that impurities will be left solid after the metal has reached fusing point; also it often happens that oxides form which have a higher melting point than the actual metal; for instance, in aluminium, as already mentioned, alumina forms, and has a melting point much in excess of the melting point of the aluminium (about 5000 deg. Fah.). The purpose of using flux is to float off these impurities, or to produce a deoxidising effect which will retard the forming of oxides, and therefore keep the metals clean for welding together. These fluxes, like welding rods, form a speciality in manufacture, and include various mixtures. Samples of flux for iron, and flux for copper and brass, are here shown. Fluxes should not be used by spreading on the weld, but should be used by dipping the welding rods into them and transferring to the weld.

PREPARATION OF PARTS TO BE WELDED.

It is important to make some preparation to the pieces to be welded, and in this there is a certain amount of scope for sound judgment on the part of the welder to make the most suitable preparation for the nature of the weld to be made. However, for straightforward work there are one or two points which apply generally. Plate work of a thickness of less than $^1/_{16}$in. can be welded with straight edges—Fig. 8—then for thicknesses between $^1/_{16}$in. and $^3/_{16}$in. the edges of the pieces should be bevelled slightly. With plates or pieces of thicknesses between $^3/_{16}$in. and $\frac{5}{8}$in. the angle of the bevel should be increased, and for thicknesses exceeding $\frac{5}{8}$in. the pieces should be double bevelled. In all cases the bevelled edges should be cleaned to remove any oxide that may exist. This bevelling is necessary so that the operator can reach the far side with the flame and welding rod, as in cases where

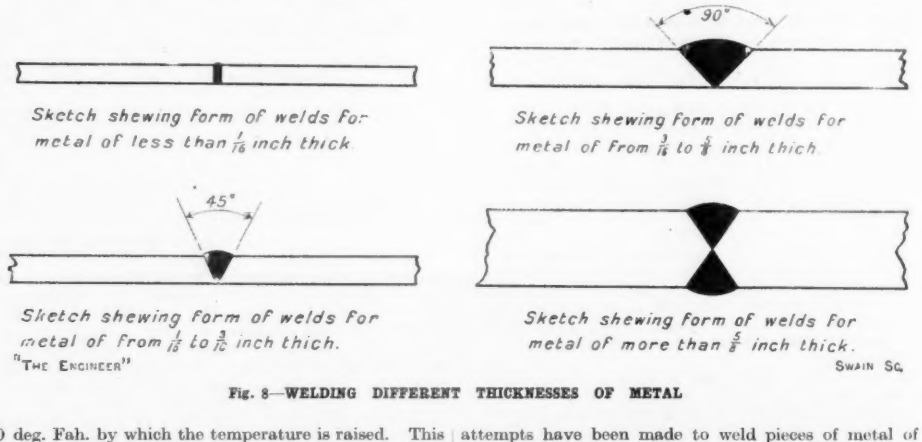

90°
45°
Sketch shewing form of welds for metal of less than 1/16 inch thick
Sketch shewing form of welds for metal of From 3/16 to 5/8 inch thick
Sketch shewing form of welds for metal of from 1/16 to 3/16 inch thick.
Sketch shewing form of welds for metal of more than 5/8 inch thick.
"THE ENGINEER"
SWAIN SC.

Fig. 8—WELDING DIFFERENT THICKNESSES OF METAL

attempts have been made to weld pieces of metal of a reasonable thickness, without first bevelling the edges, the metal has melted throughout the whole thickness at the same time, and the small white flame has swept the molten metal away on the near side, thus spoiling the weld. Incidentally, it may be worth mentioning here that the small white portion of the flame should never come into contact with the metal.

PRE-HEATING.

One of the sources of trouble in welding is the liability to develop cracks, and result in a broken weld; but this liability can be greatly reduced by the practice of preheating. In the welding of metal it is necessary to raise the temperature of the metal from that of the surrounding air to the melting point of the metal, and one of the advantages of preheating is that whole pieces of metal to be welded can be expanded, so that after the weld has been made a uniform contraction will take place and prevent breakage of the weld. It is not the expanding of the metal that is the cause of damage so much as the contracting, for a weld may appear to be good and satisfactory after completion, but unless some allowance has been made for the contraction, a break is more likely than not to occur. It will be gathered from this that a technical knowledge of metals is a valuable asset for a welder; for instance, a man without any knowledge of the melting points of various metals could easily overheat a metal with a low melting point, such as aluminium, to such an extent that when he went to the heating stove for the metal he might find it had disappeared. Another advantage in preheating lies in the fact that a certain amount of economy in the oxy-acetylene flame can be experienced, owing to the melting point being more easily reached after preheating.

APPLICATIONS TO AUTOMOBILE ENGINEERING.

Welding is not a practice that is adopted to any great extent in the production of automobile parts, and several reasons can be put forward to account for this. In the first place, there are comparatively few parts used in the construction of automobile work that can be most easily manufactured by adopting the practice of welding. Secondly, a certain percentage of manufacturers hold a positive dislike to the joining up of two or more pieces of

metal to form one article by the process of welding, and this dislike may have originated from the previous experience in welding; but there is the possibility that wrong assumption may have been made, since the failure of the welding of certain parts may have been attributed to the difficulty to weld these parts, when the real trouble has been the lack of ability on the part of the operator. Again, the making of the parts by the method of welding metal together usually means sharp corners—more or less, of course—according to the part being manufactured, and people are to be found who detest the sight of anything but a gradual change of plane in which the metal lies.

The question of the appearance of a finished article allows for a certain amount of latitude in the choice of the method for manufacture; for instance, the outward appearance of the touring car must be of an attractive nature, whereas in the commercial vehicles the appearance is of no importance within certain limits. One of the outstanding features of welded parts is the fact that comparative lightness can be obtained, where the part is not subject to much stress, by the use of thin metal. This fact should be taken advantage of in the manufacture of light cars as much as ever possible. Of course, without considering light car design, it is impossible definitely to state which parts should be built up and welded. In general automobile practice the extreme lightness which is characteristic of the light car is not required; hence, the practice of welding is not adopted to so great an extent as would be done in case of necessity; however, cases of necessity do occur. Rear axles can be built up of steel tubes, with a central bronze casting, by welding, this being the only method of making a sound permanent joint. Parts such as water pipes should be built up by welding, all flanges being welded to the pipes, and branch pipes welded to the main pipe. Flanges can be welded to exhaust pipes, and silencers can be completely built up by welding; but this is not altogether practicable on account of the difficulty of dismantling if it becomes necessary for cleaning inside. Brackets of various description can be built up by welding, but where thin metal is required pressings become a reasonable competitive proposition; however, where different thicknesses are required on a part pressings are impossible for the complete part. Radiators made up of pressings welded together are quite a commercial proposition, especially for commercial vehicle work, and can be turned out in quantities quite easily by an intelligent operator. For touring car work cast radiator tanks and brackets are preferable on account of a better appearance being obtainable.

In the experimental department of an automobile manufacturing works, welding can be applied with some advantage, for the cost of patterns for castings might be eliminated to a great extent. Alterations to the compression of an engine can be carried out by cutting the connecting-rod and welding up to make it either longer or shorter as required. Lugs or bosses can be welded to castings or other existing parts; in fact, the practical use of welding in the experimental department is almost unlimited. In foundry work the practice of welding is also applicable, as in the trimming of castings slight breakage frequently occurs, and repair by welding is preferable to scrapping the casting.

REPAIR WORK.

Breakages are more or less frequent in almost every detail used in the construction of automobile work, and previous to the adoption of oxy-acetylene welding for the repair of such breakages, the parts had to be replaced at some considerable expense to the owner. Now that the art of repair to breakages has become a satisfactory proposition, the parts thrown over to the scrap heap by the automobile owner are less numerous. However, to the automobile manufacturer the carrying out of repairs is a much more satisfactory proposition by replacement than by patching up the existing part, both as regards to finance and labour, except in cases where the part is of ancient design, and some difficulty would be experienced in getting a single part through the works. The fact that difficulty is often experienced in getting spare parts through a works has probably been a stimulant to the interest taken in the repair of broken parts by oxy-acetylene welding, with the result that certain firms lay themselves out entirely for such work.

In the execution of repair work by welding it is equally necessary, if not more than in building up of new parts, that the operator should have a technical knowledge of the qualities of the parts with which he is dealing in order that the parts may differ as little as possible from the original part. In the repair of automobile engine cylinders, a work which has come very much to the front, unless great care is taken the bore centres may differ from the original centres, or the bore may be excentric to some degree; but a technical knowledge of the metal and work to be performed by the cylinder when in use will enable the welder to make sufficiently adequate preparation for welding. It is the lack of sufficient preparation that is often the cause of the failure in repair by welding.

It would be difficult, if not impossible, to go into the question of the character of the possible repairs to each automobile part, as all breakages differ in some way or other. A common breakage in cylinders is in the water jacket, often caused by the freezing of the water, and such breakages can be repaired satisfactorily by welding; one point worth noting is that all damaged metal should be cut away in order to make a clean surface for welding.

Base chambers and gear cases are among the parts requiring careful handling and preparation in repair work, the main difficulty in these parts being the liability for error in the alignment of the bearing. However, by careful preparation in the way of adjusting the broken parts and preheating, this difficulty should be overcome. Where the metal is damaged, the damaged parts should be cut away and a new piece welded in. No satisfactory result can be obtained by pouring molten metal into a crevice, as adhesion takes place instead of the new and old metals becoming joined as one piece, with the result that when the new metal cools down cracks are almost certain to appear. Parts such as base chambers and gear cases are mostly made in aluminium, and in repairing aluminium the work should invariably be preheated to about 600 deg. Fah. Breakages in frames can be satisfactorily repaired by welding; but, as a rule, it is advisable to back up the portion of the frame in the vicinity of the repair with a plate, because a breakage in a frame is a sign of weakness, due more often than not to unfair distribution of the load, on the part of the owner or owners' representatives. Teeth can be welded to broken gear wheels, but this work should be carefully adjusted and clamped, then preheated before actually welding. The tooth or teeth to be welded in should be positioned by a plate, having slots cut in at the correct pitch of the teeth, so that the plate fits to portions of each of the two pieces to be welded together. Parts such as steering levers, gear levers, axles, &c., should be prepared carefully to allow for correct alignment before actually welding. Mud-guards are parts which often meet with accident, and such parts can be repaired by welding and thus saved from the scrap heap.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COAL ECONOMY.

Sir,—The above subject is evidently of interest to some of your readers, judging from the two letters from Mr. Townsend and "Steam Raiser," in your issue of the 10th inst.

Mr. Townsend considers some of my conclusions open to grave doubt; but I can assure him no statement has appeared in my two previous letters which are not records of results secured in this locality, and the boilers are still working daily under the conditions mentioned, and can be inspected by anyone interested in the subject.

The experiments of MM. Shuerer-Kestner and Meunier in 1868 and 1869, mentioned by Mr. Townsend, do not assist us in the matter of unburnt carbon or smoke, as with 257 cubic feet of air per lb. of coal, as stated in their record, the approximate CO_2 would be 12 per cent., and the temperature of the furnaces therefore being well over 2200 deg., or sufficiently high to ignite the gases as liberated, thus preventing black smoke. In their second test, with less than half the above volume of air per lb. of coal, or only 75 per cent. of the theoretical volume required, if only 1 per cent. of carbon was collected from the gases, a large percentage must have adhered to the boiler surface and brickwork, and the gases emitted from the chimney would only be slightly coloured.

I have no doubts relative to the two boilers Mr. Townsend mentions as giving off smoke and still fairly high CO_2 readings and good efficiency, these conditions indicate a high furnace temperature, and, consequently, the smoke period would be very short, and caused by stoking over the whole area of the fires instead of on each alternately, and if he will carefully read my last letter he will find I mention 10 per cent. of the fuel as escaping during a smoky period only, and as this could not be more than a few minutes per hour, it would only affect detrimentally the efficiency of the boiler proportionally to the black smoke period. If Mr. Townsend will test one of his own boilers with the ordinary 6ft. grates, then make the proportion of grate to outlet 2 to 1, and re-test, he will, I think, quite agree with all I have advanced relative to the value of shorter grates, as there is no doubt in this direction economy will be secured.

Anyone interested in the proportion of unburnt fuel in black smoke may test my figures with but little expense by adopting the following suggestions:—

Near the base of the chimney erect a small suction fan, coupling to its feed side a 6in. pipe, this to be carried across the bore of the chimney, and perforated with a number of 1in. holes, the fan to discharge into a chamber 6ft. square, fitted with canvas screens to intercept and filter the gases, the outlet from the chamber to be near the bottom to enable the attendant to measure the escaping gases with the ordinary anemometer.

As soon as the attendant stokes his fires, the fan damper is opened and closed again immediately the black smoke is over. This process to continue periodically for a few hours, then the volume of gas which has passed from the chamber can be totalled, also the time, and the soot deposit carefully weighed. It will be found the deposit equals about two grains of carbon per cubic foot of dense black smoke, and one grain per six cubic feet for brown smoke, and the CO_2 readings of the products of combustion will indicate the weight of air per lb. of coal by which means the loss during the black smoke period may be easily calculated.

With reference to "Steam Raiser," I fully appreciate his caution, and the semi-humorous strain of his letter, and regret his past experience has filled him with doubts; he may, however, rest assured the mythical instrument (CO_2 indicator) to which he refers, is neither of Grecian nor German birth and value, but real Yorkshire, where we never "Do owt for nowt," and is as useful to the boiler fireman as "Steam Raiser's" indicator is for himself when taking a diagram of his engine.

The cause of the present coal wastage I have already indicated, and the cure is easily and cheaply applied, but to maintain it our boilers should be more carefully attended to, and every effort made to assist the stoker with the necessary plant tending towards economy. "Steam Raiser" in his last paragraph is sceptical if nothing more; but if he or any other reader is seriously desirous of improving the economic value of his steam plant, and secure the coveted letters he mentions, £ s. d., I shall be pleased to assist him as far as possible, free of charge, if he will write me dir ct, on the following conditions:—One-half the saving effected during the first six months after my suggestions are adopted he shall divide equally between the Red Cross Branch and Hospital for wounded soldiers in his locality.

I would suggest that as smoke is only one of the products of imperfect combustion, our attention should be devoted to improving the conditions of our boiler furnaces to prevent its formation rather than quibble on details, as if the fires are right black smoke is quite impossible; why then strain at the gnat but swallow the camel?

Let us take our example for the boiler-house from the chemist in our steel works, dye works, &c.; they work to exact proportions and are sure of their results every time, and, as we know, the proportions of air and coal to give the highest efficiency, and, therefore, a smokeless chimney, why give double the weight of air and express surprise at our big coal bills?

It is four weeks since this discussion commenced, in which time another four million tons of coal have been wasted, and we are still moving on in the ruts left by our ancestors and chanting, as indicated by our conservative indifference, "As it was in the beginning, is now, &c. &c." In conclusion, as "Economy is Patriotism," is it not as great a crime to waste coal, one of our chief national assets, as it is to waste bread? Alongside each poster "Eat Less Bread," the Government should place a second one, making its order imperative, "Use Less Coal."

W. H. Casmey.

Wakefield, August 14th.

Sir,—I have read Mr. Casmey's letter in your issue of last Saturday, and can agree with many of his suggestions, especially that of reducing the size of our fire-grates. For providing steam at the mill I have charge of, we have two Lancashire boilers, 30ft. long, 9ft. in diameter, and I am working these with grates 3ft. 6in. long, our total power being equivalent, during the winter months, to an evaporation well over 2000 gallons per hour, the evaporation per pound of coal being over 9 lb. From many years of experience as a mill engineer, I am satisfied that 2ft. of grate, or even less, to 1ft. of outlet from the furnace flues, will give better results than the present practice of grates 6ft. long. I hope this practical illustration will be useful.

August 9th. Interested Engineer.

HOT BULB ENGINES.

Sir,—Your correspondent's very interesting little article on Hot Bulb Experiments, in your issue of the 10th, in itself shows how difficult it is to account for troubles with such engines, and how dangerous it is to dogmatise on any point of design. I was, however, much struck by his inability to account for the failure of his design No. 4. May I venture to suggest a cause, though it seems such an obvious one that I think he must have taken it into consideration?

The jet of fuel as it issues from the nozzle must spread out, and in that design the lower part of the jet would strike the joint between the bulb and the cover and be condensed and fall on to the cover and piston, and cause smoke and waste of fuel, whereas in No. 3 the jet is coaxial with the passage into the bulb, and no such action could occur.

In the case of No. 4, this could have been obviated by canting the bulb still further over, and slightly altering the angle of the nozzle. The conditions in the two cases would then have been more nearly comparable.

Basil H. Joy, M.I. Mech. E., M.I.A.E.

London, August 10th.

Sir,—Your correspondent's description of his experiments with hot bulb engines is most interesting and useful. How very much sooner we should arrive at the perfect engine, and what capital would be saved, if all concerned would give their experiences freely in this way. The reason of this reticence is, I suppose, the fear of competition; but is there a hot bulb engine manufactured in this country at the present time that has really attained sufficient merit to be worth reproducing? I think not.

It appears strange that your correspondent's experiments should have such varying results with the designs of cylinder heads as shown. May I ask if the same oil-spraying jets were used in each case? More details of the experiments would, I feel sure, be much appreciated by all interested in the subject.

One supposed bad feature of this type of oil engine is the water drip used in the cylinder, and I notice from your advertisement columns that several claims are made dispensing with the use of water in the cylinder; but your correspondent admits easily obtaining 25 per cent. more power, using the same quantity of fuel oil if water drip is used. Now, as we are all endeavouring to get the most power from a given capacity of cylinder, and the least oil consumed, the statement of no water drip appears to mean that a larger engine, and consequently a larger outlay in capital, is necessary for a given power.

Is water drip so very detrimental to the engine? I do not think that it has yet been definitely proved in practice; at any rate, if some form of vapour is the means of very much increasing the mean pressure in the cylinder, would it not be better if manufacturers turned their attention to overcome any detrimental effect the water may have in the cylinder?

To admit water in "drip" form is most crude, to say the least, but surely there are other means.

My own experience is that an engine with water in some form admitted to the cylinder is a much more "lively" and economical unit.

Perhaps some other readers of The Engineer may be tempted to give their experiences with this interesting type of oil engine.

August 11th. A. J. W. G.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Iron Trade Extension.

There is important news this week concerning iron trade extension in Staffordshire. Confident that an increasingly prosperous future attaches to the demand for manufactured iron of British production—contrary to the belief which in many quarters has of late repeatedly found expression that iron had been killed by steel—Staffordshire ironmasters are resolved upon considerable extension of their industry. Several sites have, it is now stated, been selected for the erection of new works, and in one case the proposals have assumed such pretensious proportions that it has been resolved to expend £250,000 on modern enlargements. The owners in question have given the subject anxious consideration, and in the past have adopted many labour-saving devices. The firm is one of much repute and possesses a name for high-class material. There will not be any waiting for the end of the war, but it is understood that the works will be pushed on at once to meet the great expansion of home and foreign trade that is predicted.

War Bonus for Ironworkers.

The Standing Committee of the Midland Iron and Steel Wages Board has decided in favour of an additional war bonus to ironworkers within its area whose wages are not based on the sliding scale. In the case of able-bodied men the increase will be 3s. per full week of six days. Youths will receive 1s. 6d. This is the fourth bonus granted since the war began, and brings the total increment up to 15s. a week for men. Quite recently an advance of 5s. was agreed to. The latest bonus, which takes effect from August 1st, is in conformity with a general movement, and re-establishes an equitable relation between the wages paid under the Wages Board "sliding scale" to ironworkers proper and those of the unaffiliated workers. Satisfaction is expressed over the settlement. It seems that a formal claim was made by the operatives' section of the Board to bring workers now paid on the day system, including helpers, labourers, and some other operatives, under the governance sliding scale system, which hitherto has applied only to millmen and forgemen. The employers urged that a general percentage advance to these men covering the various increases under the Wages Board during the war was practically impossible. The 3s. per day advance is, it appears, in accordance with the award recently made by the heads of the engineering trades of the kingdom. On the understanding that its formal proposal shall be considered later on the operatives' section has accepted the present 3s. advance, and the larger question is deferred for two months, at the end of which time a special meeting of the Board will be held. Some ironworks labourers are already receiving as much as £2 per week, their wages having risen 12s. to 15s. since the outbreak of war.

Finished Iron Activity and High Prices.

Finished iron and steel makers have resumed work after the holidays with orders before them which, with the best expedition of which they are capable, will engage their full resources for months to come. Curtailment of supplies to the general trade is progressive. Values are very firm. Where the Government "control" applies maximum prices rule. But a large proportion of the output, particularly that of the bar mills, is of special qualities not covered by the official standards, and as to these, prices are much higher than the Government schedule. The regular inquiry for supplies of manufactured iron and steel has been reinforced by special inquiries relative to material which is wanted in the very near future for fulfilment of urgent contracts. Makers' order books all round are congested, and producers' resources are so fully taken up either by direct Government contracts or by the requirements of controlled establishments, that, as already intimated, very little attention can be spared to the general trade. The bar mills have several months' work on hand, and could find regular employment for a much larger productive capacity. A considerable proportion of high-grade material is being turned out to special specifications. Standard qualities realise the full maximum prices. Marked bars are £15 10s., less 2½ per cent., and merchant bars £13 15s. net at makers' works in each case. Small rounds are £18 per ton, and hoops £18 10s. There is a steady demand for nut and bolt iron at £14 5s. to £14 11s. 3d. net, according to quality, delivered in the district. Nut and bolt manufacturers have heavy orders going through the works. Here, as elsewhere, more importance is attached to delivery than to price. As to other uncontrolled commodities, gas strip realises about £15 10s. to £15 15s. per ton. Owners of sheet mills are accepting practically no engagements outside official requirements. The latter are only moderate in compass, and are confined as much as possible to plain sheets. Makers still quote £28 10s. for corrugated galvanised sheets of 24 gauge. Black sheets fetch £19 10s., with £20 15s. for painted sheets. In working up sheets a good business is mentioned at £22, while £20 is given for defectives. Thin sheets for stamping purposes are quoted at £24 per ton.

Pig Iron and Basic Material Demands.

The late holidays have afforded something of an opportunity for mitigating the stringency as regards raw material supplies. A good deal of the pig iron turned out during the week is already on its way to the consumer, however. Smelters say that in the present condition of demand, whatever small stocks may have been put together during the holiday suspension will be absorbed within a very short time. Producers are not disposed to sell on any considerable scale. Staffordshire and Midland foundry iron is in special request for supplies of castings for military purposes. Cold blast iron for work is also in more notice. Forge finds a ready sale. Selling prices are very firm. Up to £9 is given for cold blast iron, and part-mine foundry realises £5 2s. 6d. and £5 5s. Forge iron contracts are repeated at £5. There is no change in the values of Derbyshire and Northampton sorts. Orders cannot be placed for either spiegel or hematite iron. Maximum prices current for pig iron are; South Staffordshire, common forge iron, 95s.; part-mine forge, 100s.; foundry, 102s. 6d.; Staffordshire all-mine forge, 115s.; all-mine foundry, 120s.; warm air all-mine forge, 145s.; and warm air foundry, 155s. Lord Dudley's cylinder quality of all-mine iron is 167s. 6d., and cold blast iron 182s. 6d. North Staffordshire makers quote: No. 4 forge iron, 95s.; foundry numbers, 97s. 6d.; and basic also 97s. 6d. Midland makers quote as follows: Northampton No. 4 forge iron, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 ditto, 92s.; and No. 1 ditto, 94s.; while basic iron is 97s. 6d. Derbyshire: No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; and No. 2 and No. 1 foundry, 94s. 6d. and 96s. 6d. respectively.

The Steel Trade.

An enormous amount of work is still being pressed on steel makers in Staffordshire and the Midlands in connection with the wants of war work. Steel for the Munitions and for the other departments of the Government is called for at a constantly increasing rate. The future is regarded as likely to result in an exceptionally heavy trade. There are inquiries for unlimited quantities and no dates are fixed for deliveries. These circumstances favour a very firm feeling, and opinions are expressed that a greater business may be confidently looked for, though how to deal with it is a difficult problem. It is certain that it cannot be met without provision for a considerable extension of works to increase the output. American steel imports at date are almost exclusively officially arranged supplies, no part of which finds its way on to the market. The only exception of late has been wire rods, of which small consignments come forward. They realise about £29 10s.

Government Work in Birmingham.

Except in some branches of manufacture which are not convertible to war purposes, the Government pressure of orders on Birmingham manufacturers of many kinds shows no signs of slackening. Some of our local industries which have been reorganised to meet the crisis are in a less precarious position than they were a year ago as regards regular orders for munitions. To-day, if they have the plant and labour, they can be pretty sure of getting the orders and the raw material with which to fulfil them. The construction of new works and factories for special purposes is by no means at an end.

Wages in the Birmingham Brass Trade.

The operatives in the brass trade have made an application to the Employers' Association for an advance in wages to bring them up to the level of the employees in the engineering and allied trades, contending that they have so far received increases amounting to only 12s. per week, as against 15s. in the engineering trades. About 4000 men are affected, and the application has been referred by the masters for decision to the Government Committee on Production.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THERE is no change in the general situation as regards iron and steel. The only question of interest at the moment is whether or not the American Government will do anything drastic in the way of fixing prices, and, if so, whether we, on this side, shall receive any benefit. As the increase in American production has been enormous during the last three years, there should be a respectable tonnage, both of steel and of copper, which must be sold for domestic purposes. Now, although it is true that extravagant prices do not deter a Government from purchasing what it needs for a war, they do deter private buyers, and work their own cure by checking consumption. The question is whether American domestic consumption of iron, steel, and copper is being checked on a very large scale by the tremendous heights to which the markets have attained. If so, then there will be a chance for the renewal of imports of American steel into this country. It is said that our Government is arranging for large imports of cotton; and it may be convenient to load a few thousand tons of steel billets in the cotton ships, if they can be bought at anything like a reasonable f.o.b. price. The last price heard of for billets was about 100 dols. per ton; of course, this is out of the question; but 50 dols. leaves quite a big margin of profit to the American producer, and he may come to that rather than allow his output to fall again.

Forge Pig Iron.

It is reported that large quantities of Cleveland forge pig are now going into Scotland, to be converted into manufactured iron there. The official price of this pig iron is 92s. 6d. at the Cleveland furnace, as against 90s. at the Midland furnace—Derbyshire or Lincolnshire—and the cost of getting it to the forges in Scotland is more than the cost of getting Derbyshire forge iron to the forges in Lancashire. One would be glad to know why the latter forges are not making iron, for it is urgently needed at the present time. Is it that the Scotch works are more favoured in the matter of labour? And can they obtain the needful wrought scrap iron more easily than their Lancashire competitors? It is well known that Lancashire is short of skilled labour, and it is not possible to turn an unskilled man into a puddler of pig iron.

Foundry Iron.

There is no sign, as yet, of any revival in the demand for ordinary foundry iron in this district. Sellers do not look for it before the third week in August, and are prepared to wait until the end of the month, and, perhaps, well into September before they will need to feel any anxiety as to the state of their order books; so one cannot find any tendency to seek for sales or to shade prices at all in order to obtain them. Practically only Derbyshire and North Staffordshire foundry irons are being offered, and the prices remain at 98s. 8d. and 102s. 6d. respectively. Lincolnshire and Cleveland irons are off this local market, and the offers of Northamptonshire and Leicestershire irons are very intermittent. Of course, a small business in Scotch foundry iron continues to be done at the legal prices.

Semi-steel.

There are no quotations here, either for American or English billets.

Scrap.

A good deal of interest is being taken in heavy wrought scrap, because it is felt that some change in the conditions must soon be made. The position, so far as the straightforward dealer is concerned, has become altogether intolerable. Either he must do as some of his competitors are doing, and evade or ignore the regulations, or he must suspend his business altogether. It is said that the authorities are now inquiring into the matter, and it may, perhaps, be hoped that the result of their inquiries will be the abolition of the restrictions. At the time these were published, it was pointed out that they were very unfair, and would probably be unworkable, and the forecast has been amply justified by events. The legal maximum for heavy wrought scrap is £5 5s. to £5 15s. per ton. The actual value to the consumer is from £6 5s. to £6 15s., and he would willingly pay the higher figure to secure a continuous supply. The only result of the regulations has been to throw the whole trade into confusion, and considerably to hamper the very important business of iron manufacture. Heavy steel turnings are also still in an anomalous position. The legal limit of 50s. on trucks has not yet been withdrawn; but sales have been reported at 60s., and even 65s. per ton. There is certainly no business to be done at 50s. Ordinary heavy steel scrap remains very quiet here; but there is no attempt to obtain orders at the expense of the price. There is a small local demand, and buyers pay the maximum of 105s. on trucks plus 2½ per cent., but no demand comes from Wales or from the North-East Coast. Too much scrap is made in Lancashire for dealers to be able to do without the Welsh or the Cleveland market, and it is only a question of how long they will be able to wait. The Welsh market would probably now take some steel scrap at 105s. on trucks here, but there is no margin for a profit. Foundry scrap is naturally quiet, waiting for a revival in the buying of pig iron. In the absence of much business, however, dealers comfort themselves with the reflection that the supply is still comparatively small, and, so far, no concession has been made in the price. The ordinary qualities of broken castings are quoted at 102s. 6d. per ton delivered to buyer's station in the Lancashire district; while for good qualities of broken machinery metal, 105s. to 107s. 6d. is wanted. Special spinning machinery scrap, 110s. to 112s. 6d.

Metals.

The official prices for copper are unaltered; strong sheets, £160 per ton; rods, £160; copper wire, 1s. 5½d. per lb.; solid drawn tubes, 1s. 7½d.; brass condenser tubes, 1s. 6d. The position in America remains obscure, waiting a settlement of the war prices and of the labour question. There seems to be a belief that prices will be lower, but in the absence of speculation no advantage can be taken of this general feeling. English ingot tin is quoted here by merchants at £242 per ton.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a very busy condition of things in the hematite pig iron trade of this district. Makers are experiencing a very full demand for their iron, and they are producing a big volume of metal. There are in all thirty furnaces in blast, and the whole of the iron is going into immediate use. So far as Barrow is concerned, the steel works account for the greater proportion of the output, but some of the make is also sent elsewhere. The shipping trade, however, apart from special lots, has been quiet for some time. Prices are unchanged at the maximum standard rates of 126s. 6d. per ton f.o.t., and special brands are at 140s. per ton. The latter is in brisk request in several parts of the country for high-class work.

Iron Ore.

After the brief holiday, the mines are in full swing again, and a good steady output of metal is assured. The hope is entertained that in the immediate future a considerably bigger tonnage will be raised. The property of the Millom and Askam Company, the Barrow Hematite Steel Company, and the North Lonsdale Iron and Steel Company, in the Ullcoats district of Cumberland, is being developed jointly. Much importance is attached to this combined effort to increase the ore output. In Furness developments are in hand. The demand for foreign ores is steady.

Steel.

The steel trade is fully employed again in every available department. The demand for semi-products is brisk, on local as well as general home account, and several of the usual commercial departments have been given over to this work. The demand for special steel sorts is easy, but rails for work of national importance have received attention. There is nothing being done in plates. Prices are unchanged all round, with heavy rails at £10 17s. 6d. to £11; light sections, £14 to £14 10s.; heavy tram rails, £14; ship plates, £11 10s.; boiler plates, £12 10s.; and billets, £10 7s. 6d. per ton.

Fuel.

There is a brisk demand for steam coal, which is at 25s. to 27s. 6d. per ton. House coal is at 27s. 6d. to 37s. 6d. per ton delivered. For coke the demand is active, with East Coast qualities at 33s. to 35s. 6d. per ton, and Lancashire cokes are at 31s. per ton delivered.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Iron Trade.

IMPORTANT changes in the production of pig iron are reported this week. One furnace on Cleveland pig iron and another on hematite have been put out of operation in each case for urgent repairs. The total number of furnaces now in blast in the North-East of England is seventy-five, of which thirty-four are on Cleveland, twenty-seven on hematite, and fourteen on special kinds of iron. Business has been of a very quiet and routine character this week. Home consumers are evidently in a very comfortable position, for they are coming forward for their supplies under the August allocations very slowly. With foundry iron plentiful, they have no occasion to hurry, and are only buying as occasion requires. There were rumours on the weekly market of a possible change in the maximum home prices, but, although the adequacy of these prices has been in question for some time past, there appears to be no tangible foundation for any reports as to readjustment. Such changes cannot be contemplated apart from the risk of consequential changes all round, and this may well induce hesitation on the part of the responsible authorities. For home consumption, No. 3 Cleveland, No. 4 foundry, and No. 4 forge are 92s. 6d., with a premium of 4s. for No. 1. The export position is quiet. The export f.o.b. quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

On every hand there is marked activity in the hematite pig iron trade of this district. The requirements of makers of munitions of war continue to be very heavy, and will be even heavier in the future, and smelters have no light task in meeting the demands. Supplies of both ordinary iron and special sorts are equally in big request. The blowing out of a furnace on hematite necessarily adds to the stringency. Reports show that the deliveries to home consumers are in the circumstances being well maintained, but the reduction of the output cannot but affect the allotments for export to the Allies. It was expected that before this one or two additional furnaces would have been put on hematite; but certain difficulties have not been wholly overcome, though the furnaces are ready. The maximum home price of East Coast mixed numbers is 122s. 6d. The export prices are quite nominal at 137s. 6d. to France, and 142s. 6d. to Italy.

Iron-making Materials.

In the foreign ore trade a moderate business is passing. Coke is rather easier, with good medium furnace kinds quoted around 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

With the near approach of the annual holidays, a feverish activity has prevailed this week in every steel-making establishment in the Cleveland and Teesside districts, and great efforts have been exerted to get all the

orders in hand executed and put out before the works shut down. The demand for all classes of steel material is urgent and insistent, the entire production being utilised either directly or indirectly on Government account. This extraordinary industrial activity is pushing the ordinary home and export trade further and further into the background, the only steel which is leaving the district being some shipments to France. Steel bars, mercantile and shipbuilding requirements are turned out with all possible speed, and in largely increasing quantities. There is little new to report concerning the manufactured iron trade. So extensive is the nature of the Government work being dealt with at the moment, that the claims of ordinary customers can only be considered in a restricted measure. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ⅜in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 3/16in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12—all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

There has been extremely little movement in the scrap trade this week. In many cases deliveries of material have been eased, owing to the approaching holidays. The position still seems to be firm all round, but quieter so far as new business is concerned. There is not the same urgent inquiry for steel scrap of the ordinary sort, and it seems likely that buyers have fairly well satisfied themselves for the present. A lull till after August is quite probable. The market for foundry scrap is also a good deal quieter, owing in a large measure to the fact that foundry iron is now in good supply. The position as regards wrought scrap is unchanged; holders still decline to sell at the maximum rates. Current prices are:—Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, ¾in. thick and over, £6 5s.; heavy wrought iron scrap, ¼in. thick and over, £5 5s.

The Coal Trade.

The situation in the Northern coal trade is still unsatisfactory. Though the collieries have worked a little more steadily. Business, however, has been of a meagre description, and leaves the market stagnant and stationary. Some of the second-class collieries, and especially those producing the cheaper qualities of bunker coal, are suffering particularly from the new prices and classification since they cannot compete at the same price with the better brands on the market, and find their trade slipping away. It is beginning to become evident that in fixing ordinary Durham bunkers at 24s. without distinction the new classification must operate very harshly on the collieries producing the second and third qualities of bunker coal. The question of arrears of contracts is looming large in the trade, and promises to be the subject of negotiation between the Coal Controller and the several district committees which have been appointed to represent the colliery owners and the exporters. Naturally, exporters and middlemen are not a little concerned regarding the proposal of the Coal Controller to cancel arrears on contracts. In the past, a give-and-take policy has ruled as between coalowners and contractors as regards arrears not taken out, but it is the evident intention of the Controller to wipe out these arrears as far as possible. In those cases where contracts are above the schedule prices laid down by the Controller for coals for export, contractors will feel more relieved than otherwise; but in some other cases, owing to the difficulty of contractors in getting superior quality coals, as the result of the Admiralty demands, arrears go back to pre-war days and stand at very low prices in many cases, as compared with current figures, so that the cancelling of arrears will cut both ways. This week the market has been devoid of anything of outstanding interest. The Norwegian Railways are fixing up for their requirements, which are reported to be on a much larger scale than anticipated. This will, undoubtedly, improve the prospects of the steam coal section, especially in the case of the Northumberland pits. In the meantime, best steams are dull, and all the other grades of steams are correspondingly slow. The gas coal trade is a little better than steams, but there are plenty of supplies. Coking fuels for export are not active, but the home demand is very fair. The coke market is on the whole steady. The home demand is fairly well maintained. Quotations are as follows:—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 26s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gas-house coke, 30s. to 31s.

SHEFFIELD.

(From our own Correspondent.)

In Full Swing Again

STEEL works managements allowed a considerable degree of latitude to the armies of men and women over the August holiday break. It was generally recognised that a day or so extra had really been very well earned, and, as a matter of fact, many of the firms were rather glad of the delay in full resumption of operations to complete repairs or to clear off stocktaking. Comparatively few recommenced work seriously on the Wednesday, and it was Monday morning before the holiday spirit was thrown completely off. As I write, however, the workers are getting into their stride again, though some of them appear to entertain an idea that another short break will be made in October. Where they got it from I do not know, except it is that last year there was a munitions workers' holiday in that month; but, of course, the reason was that the Whitsuntide and August holidays had to be postponed in consequence of the severe pressure experienced for war material of all kinds. This year things have been kept so well in hand that not an ordinary holiday has been missed; therefore no ground seems to exist for claiming another holiday in October. The next break will be at the end of the year, by which time, let us hope, the end of the war will either have come or will be clearly within sight. Regarding Sunday work, my personal sympathies had been with those firms and workers who were earnestly desiring to see it gradually eliminated so far as is possible, because there seems no shadow of doubt that work done during a six-days week is greater in volume and superior in quality to that produced in a seven-days week, when the latter has become a regular practice; but from what I learn there appears to be rather a recrudescence of Sunday work, which must mean an increased pressure for war material. That this should be so is not surprising after all, for whilst supplies for the British forces may be very well in hand, enormous quantities of steel and manufactures thereof are going to various Allies, particularly Russia.

The Steel Supply.

But as the war demand for steel rises so do the sources of supply seem to increase, entirely falsifying the view of those who long ago predicted an approaching steel famine. It is true that almost daily the difficulty grows of securing open-hearth material for general trade manufacturers, but that, of course, was only to be expected. What most surprises one is the actual quantity of steel which continues to go into private trade channels. In a sense this may be regarded as a national reserve, for as long as the manufacturers are able in any degree to attend to private orders, whether on home or overseas account, it is obvious that the war steel demand has not reached the limit of supplies. In this district the increase in output has gone up by leaps and bounds, the number of additional furnaces erected—the open-hearth type, to say nothing of numerous electric steel-melting furnaces—being very remarkable. The principal advances in that direction have been perhaps made on the Rotherham side of the district, where, for the moment, such enterprise is particularly conspicuous. Most of the furnaces here are producing acid steel, and what basic material is required is being bought elsewhere, probably in the Birmingham district. In any case, there seems no evidence of the "ever-widening gap" between demand and supply of steel which some time ago was depicted in certain quarters, and it is a matter for congratulation that at the beginning of the fourth year of the war the Government is really more comfortably off in this respect than, probably, at any time. A good deal is anticipated as a result of the organisation of our raw material resources, and when that and the problem of the requisite extra labour have been settled satisfactorily, the position should be thoroughly assured, whatever the demand may be. The ore resources appear to be proving extremely satisfactory. Speaking of that reminds me of a conversation I had a few days ago with the chairman of a large concern here regarding the supplies of magnesite bricks used in steel making. Before the war we were chiefly dependent upon Austria for this commodity, the other sources of supply being Greece and India. Deposits were also found in California, but what are probably the largest deposits in the world of very high-grade magnesia are in Australia, and the director with whom I was conversing is, I happen to know, financially interested in them to a very considerable amount. Already a million tons have been proved, and, for all that is known, there may be as much again. It just proves that after the war we need not go out of the Empire for all the magnesite bricks we require, though, of course, their close proximity to us will always be a factor in favour of the European deposits. In that case Australia has the large markets offered by Japan and China, besides which the Commonwealth's developing steel industry will provide an ever-increasing home consumption. In Sheffield, I learn, some interesting experiments are being made with a substitute for magnesite bricks, and for a good while now a special treatment of native ores has provided Sheffield consumers of Swedish iron with an alternative material, very acceptable with Swedish up at £65 per ton c.i.f., though whether, on the return of normal times, it will prove strong enough to hold its own against Swedish seems open to question.

Workers' Record for July.

Whether the chairmen of all Munition Tribunals issue a monthly *résumé* of their courts' proceedings I do not know, but Sir William Clegg's periodical statement on the subject of the Sheffield Tribunal, over which he presides, always strikes me as being interesting. On the whole the return for July is satisfactory, though one item showed a considerable increase, viz., for losing time there were 113 cases compared with 86 in June, with 9555½ hours lost against 6717 in the previous month, the average hours lost per case being 83.08 against 78.01. Practically all the other items, however, were favourable to July. They included complaints of not working diligently, 28 against 43; gambling or card-playing on the works, 39 against 42; and refusal to obey orders, 18 against 70. This last item, Sir William considered extremely satisfactory. The numbers of other cases were trivial. There were no charges of taking intoxicants into the works, and only one case of a man being worse for liquor, the total number of cases being 206 against 250. Regarding the first half of the year, Sir William notes with interest that the number of cases heard in the second quarter shows a very considerable reduction on those of the first, the figures being January 1056, February 716, March 968, total 2740 for the quarter; April 407, May 290, June 343, total 1040 for the quarter. "On the face of it," he says, "these figures appear very satisfactory. I am not prepared to say what the cause of the reduction is, whether firms now are not enforcing the regulations as rigorously as they used to do, or whether the men are conforming better to the regulations. I hope it is the latter. The facts are as stated, and everyone can draw his own conclusions." I remember that a managing director, discussing with me the tribunal figures for one month, observed rather significantly: "These are all the cases that have been brought, not all the offences that have been committed." At all events, there is the Tribunal for firms to appeal to if they wish to do so or think it necessary; but the fact is—and Sir William Clegg is not unaware of it—that firms to-day are so hedged about with rules and regulations, and have so many reports to make to this Government department and the other upon this subject and that, that they become sick of the waste of time and are tempted to let slide anything they reasonably can. To proceed against a man at the Tribunal means wasting the precious time of an official beside the man's own lost time, so that in some respects instead of being cured the trouble is increased.

The Chamber of Commerce.

Several matters of special interest to the steel industry came up for consideration at the Council meeting of the Sheffield Chamber of Commerce on Monday. One point, about which manufacturers feel very strongly, is that any further curtailment of passenger train service, as now talked of, would be very serious for Sheffield traders, most of whom are engaged on Government work. It was decided to send copies of a resolution passed to the Railway Executive, the Board of Trade, and the Ministry of Munitions, expressing the opinion that railway passes ought to be interchangeable on the various lines serving this district. The Board of Trade had written suggesting that if possible contracts should be made, f.o.b., where licences are required, because it was frequently made a part of the licence that the goods must be carried in neutral vessels. The Chamber's view upon this was that traders should, if possible, arrange for their goods to be delivered free at port, as being a better method for them than f.o.b. A communication from the Russo-British Chamber of Commerce at Petrograd stated that a law had been published there permitting duty-free importation of merchandise samples from England to Russia if addressed to that Chamber. Finally, it was decided to send delegates to a meeting in Birmingham to discuss a scheme of commercial education. This last-named proposal is of considerable importance in its relation to industrial reconstruction plans. It is a matter which in its more practical aspect has in the past been too often overlooked. Altogether the meeting of the Council was a very useful one, but I quite understand some of the members asking that general meetings of the Chamber might be held at very much more frequent intervals than is at present the case. The Council, of course, communicates its proceedings to members, but, after all, that is not the same as a meeting which every member is entitled to attend, and at which many subjects of vital interest to manufacturers might be introduced for discussion.

Round the Works.

If the Development Committee of the Sheffield Corporation is really keen in its work, there should be one or two good inquiries to deal with just now. I hear that one southern firm is anxious to find a site for a steel constructional works, and appears to favour this district as a convenient centre for its operations. Rumour, indeed, speaks of possible negotiations for the taking over of a large works and site; but, beyond that, I could not at present go, because any completion of such negotiations would mean the amalgamation of two works of considerable importance to make room for the new-comer. There are many of these stories about just now, and whilst it does not do to accept them all in whole or in part, yet there is no doubt substantial ground for some of them. On the other hand, I have heard of Sheffield firms requiring room for development, seeking information regarding sites in centres much further south. At its meeting on Wednesday the City Council adopted the recommendation of the Electricity Supply Committee to accept the offer and proposals of the Ministry of Munitions with reference to the transfer to Sheffield of 28,000 kilowatts of plant to be installed in the emergency power-house at Blackburn Meadows. The general manager is authorised to place contracts for the necessary machinery, boilers, and works at a total estimated cost of £560,000, and the Finance Consultative Committee is requested to approve an expenditure of £448,000 of the larger sum during the current financial year. Speaking of new works, the Sheffield United Gas Company is seeking permission to erect large new buildings as soon as a site has been settled upon, and the Corporation is negotiating for 16 acres of land on the Wallsley Hall estate for developments under the Housing of the Working Classes Act. Babcock and Wilcox have had their tender accepted by the Rotherham Corporation for six boilers for the new power-house at a cost of £150,500. Rotherham's activities in electrical development are on a very important scale. The latest Government tenders include inquiries for 10,000 reaping hooks, 2000 drag knives, 2000 edge knives, 10,000 paring knives, and 750 hair clippers. A couple of contracts are in hand here for driving wheel centres for the L.C.C., but municipal tramway material generally is not brisk, though there are some good foreign orders for points and crossings about. There is a home inquiry from makers of engines for heavy motor transport work.

Iron, Steel, and Coal.

More than a little nervousness prevails in the circles of forge pig iron consumers regarding the limited supplies through so many furnaces being put on to basic production. There is a very strong demand for the latter, but the satisfying of it seems to have been done rather thoroughly at the expense of foundry and forge iron. The situation is one that is being watched with anxiety. The remedy seems to be for the Government to find means of supplying labour for the manning of furnaces now standing idle. Fair deliveries of hematite iron are coming forward, chiefly of the special qualities, and the steel position remains much as before the holidays, with a constantly

rising demand. Users are wondering if the arrangements now being made in the United States will result in American billets finding their way across the Atlantic again at prices not out of all bounds. The demand for all grades of steam fuel for industrial consumption keeps on a very large scale, and the position of shipments is about unchanged, the Government requirements being exceedingly large at the ports. For inland sales best South Yorkshire steam hards are quoted 17s. 9d. to 18s.; best Derbyshire hards, 16s. 9d. to 17s.; second quality, 16s. 6d. to 16s. 9d.; cobbles, 16s. to 17s.; and nuts, 16s. 6d. to 17s. 6d. Slacks are rather easier, though colliery order books are very well filled. Best hard slacks are quoted 12s. 3d. to 12s. 9d.; seconds, 12s. to 12s. 6d.; soft nutty, 12s. to to 12s. 3d.; peas, 10s. 6d. to 11s.; and small slacks, 6s. to 7s. Supplies of house coals are as scarce as ever, and collieries are weeks behind with deliveries. Branch is quoted 21s. 6d. to 22s. 6d., and best Silkstone, 18s. 6d. to 19s. 6d., all quotations being per ton at pits.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Electricians' Dispute.

THE decision of Sir George Askwith, the Chief Industrial Commissioner, has gone against the members of the Cardiff Electrical Trade Union, who were recently on strike for a day or two, and resumed work upon the point at issue being referred to Sir George Askwith. The question was as to the interpretation upon an award made on June 8th, which the members of the Union contended placed electricians on the same level as the allied engineering trades, and gave the men 12s. per week more than pre-war rates. Sir George Askwith showed that a mistake had been made by the men in their reading of the award, and the employers' position was, therefore, maintained.

What is a Miner?

The question of recruiting from the collieries continues to attract a good deal of attention, and on the 22nd and 23rd inst. the ballot of the men in the coalfield takes place regarding the combing-out scheme agreed to between the Miners' Federation of Great Britain and the Government. The form of ballot paper has been agreed to, and only full financial members of the Federation will be permitted to participate in the ballot. Combing out of men from the mines who have gone into them since August, 1914, is, however, to be vigorously proceeded with and completed before the new scheme takes effect. Colonel Pearson, presiding at the West Wales Colliery Tribunal at Swansea, on Monday, said that, owing to some misapprehension as to who was to be regarded as a *bonâ fide* miner, a letter was written to the Home-office on July 27th, and the reply stated that it is not correct to say that a man who was a miner prior to August 4th, 1914, but had on or after that date left for another occupation is still entitled to be called a miner. The only two exceptions are (1) the men who had left the colliery for the Army and had since returned to the mines; and (2) those who were miners on August 4th, 1914, and had since been temporarily absent from accident or ill-health. It was therefore clear that a man who had entered another occupation would not be considered a miner.

House Coals.

On the point as to whether the Controller of Coal Mines' Order relative to the supply of house coal during the coming winter applies to South Wales, Mr. Finlay A. Gibson, the secretary of the District Coal and Coke Supply Committee of South Wales and Monmouthshire, states that he understands that the Order applies only to London and the surrounding districts. His Committee has not been advised that it is contemplated that the Order should be made applicable to South Wales. The Committee had a meeting on Tuesday and had under consideration the question of supplies of house coals to merchants in South Wales and Monmouthshire during the coming winter, and agreed upon a scheme which has been submitted to the Coal Controller for his approval. It is hoped that the scheme will be issued in a day or two to the clerks of county boroughs, boroughs, and urban councils.

Shipping Deal.

Mr. S. Instone, of Instone and Co., Limited, coal exporters and shipowners of Cardiff and London, confirms the report that negotiations are proceeding on behalf of the Instone Transport and Trading Co., Limited, for the purchase of a fleet of cargo steamers aggregating 30,000 tons and involving a million and a-quarter sterling. It is probable that full details of the projected purchase will be available in a week's time. The Instone Transport and Trading Co., Limited, was formed a few months ago, and is quite a separate company from S. Instone and Co., Limited. Practically the whole of the shareholders in the former undertaking are French, as the bulk of the capital was subscribed from France, but S. Instone and Co., Limited, will act as the managers of the steamers, which will be engaged exclusively in the French coal trade. S. Instone and Co., Limited, already own about half-a-dozen steamers with a gross tonnage of over 15,000.

Current Business.

The coal trade during the past week has been very active, and loading operations have been brisk. Tonnage has been in good supply, but although there was a good return, comparatively speaking, of the miners to work after their three days' holiday last week, outputs have not recovered to the extent of being equal to the normal quantity. In some cases production has been very unsatisfactory, but this is more or less always the case in August, when the miners take leave, quite apart from the official holidays arranged at the Bank Holiday period. The restricted output has, as a consequence, served to accentuate the pressure which has come most from the authorities, who have kept a very tight grip on all the superior quality coals, with the result that the ordinary exporter has had to look to other grades to meet his requirements. These grades, as a result, have also been a strong market. Schedule values have, of course, prevailed. The demand has been chiefly for coals for shipment to France, and one subject of comment recently has been the fact that it has become increasingly noticeable that orders are coming through firms, which before the war had little or no business connection with France, whereas the limitation scheme laid it down definitely that business as far as possible, should be conducted through channels existing before the war. There has also been a strong inquiry for nuts and peas, supplies of which, owing to the holidays, are scarce. Gas coals and manufacturing descriptions are also very busy, and bunker smalls are none too plentiful, but inferior cargo sorts are ample in supply for requirements. Coke is very steady at 47s. 6d., and patent fuel is firm at 30s. to 32s. 6d. Makers are fully stemmed for early loading, and have been unable to entertain prompt orders. Pitwood shows very little alteration from 58s. to 60s. Supplies are fairly good, but the inquiry is not very active, thus indicating that colliery owners are being better supplied with the home-grown product.

LATER.

The market is without any notable change. Large coals are firm, but cargo smalls are more plentiful than could be desired, and in some cases collieries are banking them. It is reported that the Coal Controller has sanctioned the price of washed smalls being modified from 24s. to 22s. 6d., and as regards the price of Swansea through bunkers it is understood that this is to be 23s. 6d. as against 25s., and Swansea smalls at 17s. instead of 19s. previously.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 24s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas, 27s. 6d.; seconds, 26s. 6d.; patent fuel, 30s. to 32s. 6d. Coke, 47s. 6d.; pitwood, ex ship, 58s. to 60s.

Newport.

Monmouthshire coals have been in good demand this week, the pressure on the superior steam coals on the part of the Admiralty having favourably influenced Newport descriptions. Small coals are not relatively as good as large, but the position regarding smalls is better than was the case prior to the holidays. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d. Patent fuel, 30s. to 32s. 6d.; pitwood, ex ship, 59s. to 60s.

Swansea.

There has not been much change in the anthracite section, which is quiet in comparison with the steam coal branch. A good inquiry for machine-made qualities. Large descriptions are plentiful. Schedule values:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 10s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, 25s.; smalls, 19s. Bituminous coal: Through and through, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates.

Work was resumed in the tin-plate trade on Monday after the usual week's holiday, and there is every likelihood of mills being engaged full time for the next few weeks, seeing that during all last week delivery of steel bars was maintained. This will enable manufacturers to clear off some of their arrears of deliveries. So far the schedule prices of tin and terne plates have not been issued by the Ministry of Munitions, and, as a consequence, makers cannot effect any fresh definite sales. Quotations:—Block tin, £242 5s. per ton cash; £238 10s. per ton three months. Copper, £125 per ton cash; £124 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

SCOTLAND.

(From our own Correspondent.)

Copper Mining in Argyllshire.

AFTER a lapse of about three years copper mining has been resumed in Argyllshire, on ground adjacent to the workings abandoned by the Otter Copper Company in 1914. A new company has been formed and the preliminary operations have yielded encouraging results.

Miners and Recruiting.

The miners in Scotland are making a very strong protest against the latest Recruiting Order. Meetings have been held, and several bodies of men have refused to countenance further demands upon young miners until a complete comb-out has been made of the men who have entered the mines since August, 1914.

Pig Iron.

Conditions in the Scotch pig iron trade show no alteration. The call for supplies for war work is still predominant. The demand for hematite from the steel works is increasing, and the output is barely sufficient. Some grades of foundry and forge iron are very scarce and at times are unobtainable. Ordinary business, both with home and overseas customers, is practically at a standstill. Prices are firm and unchanged.

Quotations.

Monkland and Carnbroe, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

All departments of the finished steel and iron trades are working under the pressure of war demands, which continue to flood the various markets to the exclusion of everything else. At the steel works plants are running at full speed, and owing to the improvements and additions recently introduced, outputs show a growing tendency. Chief interest centres in constructional material and plates for shipbuilding. Exports have practically ceased for the time being apart from Allied wants. In the black sheet trade, too, the bulk of the output is on our own and allied Governments' account. The heavy gauges are mostly in request. The price remains round about £18 5s. per ton net f.o.b. Glasgow. Galvanised flat and corrugated sheets are not on offer for ordinary trading purposes with the exception of second-hand parcels. In the malleable iron trade outputs are restricted. The greater proportion of the mills are now producing steel for war purposes, and iron is difficult to obtain. Business in the latter is disorganised pending the announcement of arrangements for the allocation of supplies to the ordinary consumer. "Crown" quality iron bars are still named in the region of £15 5s. per ton net for export. Strenuous conditions characterise proceedings in engineering circles. The position at the shipyards, too, is one of ceaseless activity.

Coal.

There is really nothing fresh to report regarding the Scotch coal trade. Markets remain dull, and prospects are not improving. The turnover week by week is not sufficient to ensure regular employment, and broken time is frequent, especially in the east of Scotland. Shipments for the past week show some improvement. In the West of Scotland district collieries are kept fairly active, owing to local industrial demands, but the outlook is not encouraging, even with the winter season ahead. Quotations are on last week's level. Ell coals, f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. In Fifeshire great difficulty is experienced securing employment. Shipping orders are very scarce, and local demands are quickly satisfied. First-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s. per ton. The general state of affairs in the Lothians is also very unsatisfactory. Best steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The aggregate shipments from Scottish ports during the past week amounted to 170,804 tons, compared with 137,039 in the preceding week, and 189,398 tons in the corresponding week of last year.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W.

ORDERS

For the week, by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Second-Lieutenent A. Ullmann.

Next for Duty.—Platoon Commander C. Campbell.

Monday, August 20th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, August 21st.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, August 22nd.—Drill and Elementary Bridge Construction for No. 1 Company, Left Half Company.

Thursday, August 23rd.—Drill and Elementary Bridge Construction for No. 2 Company, Left Half Company. Ambulance Class.

Friday, August 24th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company at Regency-street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.

Saturday, August 25th.—Commandant's Parade for Route March and Drill. Parade Putney Bridge Station, 2.45 p.m. Uniform.

Special Order.—The Commandant desires to express to all ranks his appreciation of the excellent way in which the duties in Camp have been performed. He is especially pleased that all duties, including cooking, &c., have been carried out by members of the Corps. He regrets that it was impossible to give longer notice of the Camp arrangements or, doubtless, a larger attendance would have been secured. He also congratulates the Corps upon the fact that its duties have now been defined by the Authorities.

Musketry.—All N.C.O.'s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to obtain the Capitation Grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at Headquarters, and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the Orderly Room.

Note.—Unless otherwise indicated all drills will take place at Headquarters.

By order,
MACLEOD YEARSLEY, Adjutant.

August 18th, 1917.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that with the consent of the Government authorities, a new company under the title of Korting Brothers (1917), Limited, has been registered, and has taken over the business of engineers, previously carried on by Korting Brothers, Limited, 53, Victoria-street, Westminster, London, S.W. 1. The entire assets and goodwill of the old company have been acquired and the new company will carry on the business with entirely British capital and under British management, and will develop the manufactures so far supplied by the old company in England.

THE Lep Transport and Depository, Limited, of Castle-street, Long-acre, W.C. 2, requests us to inform our readers that it is able to carry all kinds of goods—on through bills of lading—to Italy, France, and Spain by way of the Northern French Channe ports.

ATTACHMENT OF SPINDLES TO FORGED STEEL VALVES.

By F. M. McLARTY, Jun.

Forged steel valves are probably undesirable from a commercial standpoint, but superheated steam demands them, which in itself justifies consideration of the title subject. The familiar horseshoe type of attachment, —Fig. 1—still commonly adopted in the case of cast valves, probably holds its place because of low cost of manufacture, and the fact that it gives general satisfaction in use. This design, however, when applied to forged valves no longer presents the same advantages. In the first place, the shape does not lend itself towards a cheap, clean forging, added to which there is the disadvantage of having to mill out the slot in the head required to take the spindle, and—possibly worst feature of all—it is necessary to have a small pin to keep the valve central with spindle, and this, being exposed to the destructive action of superheat, is liable to give trouble sooner or later.

Turning to Fig. 2, we have an alternative attachment which, though it is hardly satisfactory in all respects, has been adopted to some extent. Compared with the horseshoe type it holds the advantage of being more positive in action, owing to the spindle head being completely encased and bearing all round its upper surface, thus dispensing with the exposed pin. The forging is also simpler, and can, if desired, be turned all over to present a finished exterior. Unfortunately, however, the head and cap must be screwed and a set pin be fitted to prevent the cap screwing off, which considerably increases the cost of manufacture, and is certain to offer difficulties in detachment after the valve has been in use for any length of time. Probably this is the most popular design at present, but if adopted care must be taken to make the securing set-pin as large as possible, and to fit it through the top of the cap, as shown,

Fig. 2

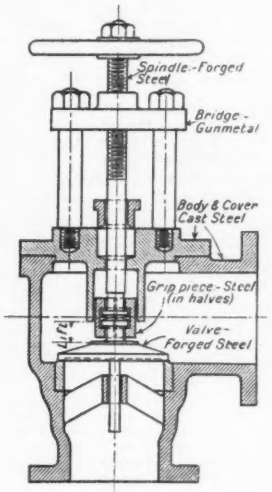


Fig. 3.

"The Engineer" Swain Sc.

and not through the side. Pins fitted in the latter manner have been known to shear through, thus allowing the cap to unscrew and become loose. A design suggested by the writer as a means of overcoming most of the difficulties to be met is shown in Fig. 3, and though the sketch probably supplies all the information necessary, a short explanation may be acceptable.

The valve and spindle are turned each with a head similar to the usual spindle head. Attachment is effected by means of a circular grip piece made in halves, these halves being held together by a cylindrical projection cast solid with the valve chest cover. In common with the previous designs, the spindle can only be attached to and detached from the valve when the cover is removed from the chest.

The following advantages are claimed :—(*a*) The valve is a simple forging, cheaply machined, no screwing or milling being necessary ; (*b*) there is no hand fitting to be done ; (*c*) the attachment and detachment are simple operations at any time ; (*d*) no loose pins or set screws are required ; and (*e*) the valve spindle is protected from the flow of steam. The grip pieces and cover projection must be a good working fit ; accordingly they should have their contact surfaces machined, which offers the main disadvantage in manufacture, as the cover will require to be reversed in the lathe for this operation. It is perhaps unnecessary to point out that when full open the valve should be in contact with the cover, the top surface of grip piece being clear of the cover.

At present there is a tendency towards case-hardening the portion of the forged steel spindle exposed to the flow of steam. In the case of the proposed new design the grip pieces could be case-hardened instead of the spindle.

In its report for the year ended June 30th, the Public Services Commission for the First Division of the State of New York said that the Commission is constructing a system of rapid transit, involving an expenditure of between 350 million and 400 million dollars, about one-half of which is being contributed by the City of New York. This system, including the third tracking of some of the elevated lines, will add 345 track miles to the existing subway and elevated rapid transit mileage, and will give New York City something more than 600 track miles of such lines—more, it is said, than all the other cities of the United States put together. The system is nearing completion, and there is a prospect that a large proportion of the most important lines will be in operation before the end of the year.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

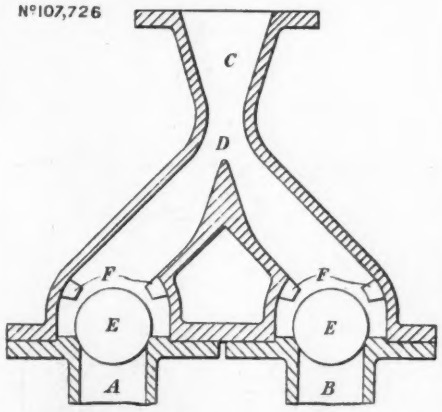
The date first given is the date of application ; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM ENGINES.

107,726 (18,493 of 1916). December 27th, 1916.—Twin-cylinder Steam Engines, John Graves McKean, 17, Ocean View, Whitley Bay, Northumberland.

This invention consists in the provision of means comprising a contracted throat which is formed at the junction of two branch pipes, one connected to the exhaust port of each cylinder, with a common exhaust pipe, so that the energy contained in the steam at the terminal pressure in one cylinder is utilised to create for the latter part of the stroke a less absolute back pressure on the piston of the other cylinder than that existing in the region to

No 107,726



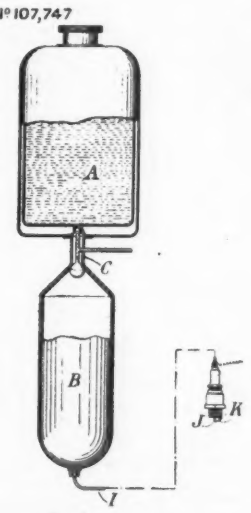
which the cylinders finally exhaust, provided that this region does not contain a perfect vacuum. The ejector consists of a branch pipe A and B connected from the exhaust port of each cylinder to a common exhaust pipe C, having at the juncture of the two branch pipes a contracted throat D. In slow running engines, valves E of the ball type, and with lugs F to limit the lift, may be placed between the exhaust ports and the throat of the ejector D, in order to prevent the return of the higher pressure in the exhaust pipe, due to the weakening action of the ejector when the exhaust operating it falls in pressure.—*July 12th*, 1917.

INTERNAL COMBUSTION ENGINES.

107,747 (598 of 1917). April 27th, 1917.—Means for Supplying Oxygen for Combustion, William Cooper Matthews, Lammascote House, Stafford.

This apparatus consists of a vacuum flask A containing liquid oxygen, to which is connected an expansion chamber B. Into this the liquid passes at predetermined times and is gasified. From the chamber B the gaseous oxygen passes, by means of the tube I, to a special form of sparking plug, the tube terminating

No 107,747

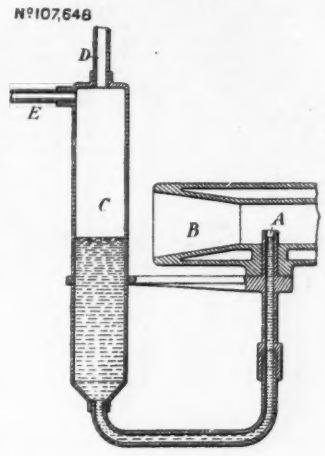


at the point J, with which the point K forms the spark gap. The two chambers A B are connected by a neck in which a double hemispherical valve C is operated either by hand or automatically. The spherical valves are preferably of glass or other hollow material from which the air has been extracted.—*July 12th*, 1917.

107,648 (9556 of 1916). July 6th, 1916.—Fuel Feeding Device, John William Hall, 70, Josephine-avenue, Brixton-hill, London, S.W.

This invention relates to a fuel feeding device for internal combustion engines of the type in which a fuel delivering device acts intermittently, or at regular intervals in the period of revolution of a multiple cylinder engine. There is combined with a variable intermittently acting fuel delivering device and a fuel jet nozzle A in the engine inlet pipe B an intercepting chamber C. To the contents of this chamber the atmosphere has access at D. Into the chamber the pump delivers through E, and from the lower portion of the chamber the nozzle obtains its fuel. The chamber is of such a depth that it accommodates above the outlet which leads to the jet a body of liquid fuel. This body of fuel put into the chamber at the commencement of operations acts as an equaliser of flow between the intermittent injections of fuel into the chamber, and the more or less continuous withdrawal of the fuel at the exit, which otherwise would be impulsive. Moreover, the depth of the chamber is such that, in spite of the

No 107,648



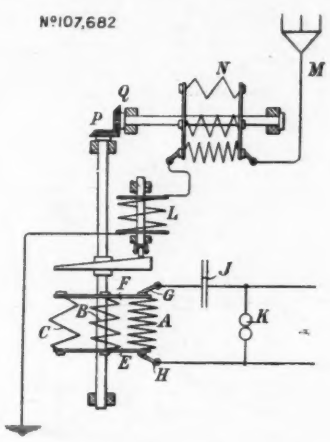
variations of the level of the liquid fuel in it, due to variations in the working of the engine supplied therefrom, there is always enough liquid fuel above the exit from the chamber to the nozzle to keep that exit submerged.—*July 6th*, 1917.

TELEGRAPHS AND TELEPHONES.

107,682 (11,055 of 1916). August 4th, 1916.—Wireless Telegraphic System, Indo-European Telegraph Company, Limited, and another, 18, Old Broad-street, London.

In this wireless system a device is provided which comprises a number of inductances A B C between two discs E F, and having terminal members on the two discs respectively, and a pair of brushes G H to co-operate with the terminal members in such a way that by relative movement between the terminal members and brushes any one of the inductances may be connected in circuit for varying as required the time period of the circuit or of replacing one of the inductances by another. The device may

No 107,682



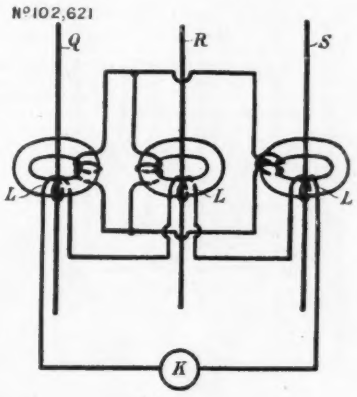
act so as not only to replace, for example, one inductance by another inductance, but may substitute for one combination of inductances another combination of such pieces of apparatus. Further, in addition to substituting one piece of apparatus for another, mechanism may be connected to the device to vary the mechanical or electrical relation or condition of devices in or in connection with the oscillatory circuit J K; for example, the coupling of a high frequency oscillation transformer or jigger. L is the secondary winding connected to earth and to an aerial M through the device N. The vertical shaft is geared by bevel wheels P Q to the horizontal shaft to make the changes in the two circuits simultaneously.—*July 12th*, 1917.

MEASURING AND TESTING INSTRUMENTS.

102,621 (17,603 of 1916). December 7th, 1916.—Earth Connection Indicator for Electric Cables, George Giles, Villa des Fleurs, 19, Avenue de Rome, Fribourg, Switzerland.

In this instrument each of the line conductors Q R S passes through the core of a separate transformer H, the core being

No 102,621

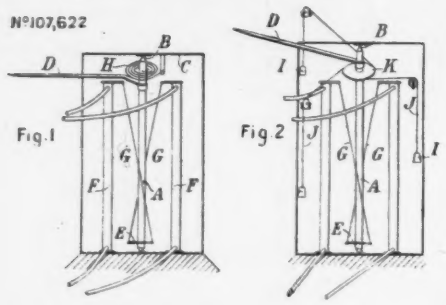


provided with a winding connection to an ammeter and with a compensating winding, in which pass the currents induced in the compensating windings of the other coils by the currents circulating in the conductors corresponding to the latter cores. The object is to produce—when the algebraic sums of the currents

in all the conductors is *nil*—a flux equal and of opposite sign to that created in the core under consideration by the current passing in the corresponding conductor. K is a milli-ammeter connected with the cores L.—*July 12th*, 1917.

107,622 (9246 of 1916). June 30th, 1916.—Device for Measuring Expansion and Contraction of Material, Marconi's Wireless Telegraph Company, Limited, and another, Marconi House, Strand, London, W.C.

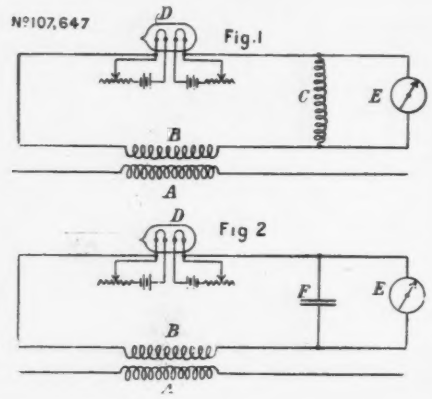
Two forms of this instrument are illustrated diagrammatically in Figs. 1 and 2. A is a spindle rotatably mounted on pivots B carried by a frame C, so that the spindle is prevented from any movement parallel to its axis. D is an indicator arm fast on the spindle, and E is a cross piece or arm also fast on the spindle. F F are two rods or columns of the conducting material, the expansion of which it is desired to measure, each having one end



fixed with regard to the frame C, and each being parallel to the axis of the spindle. G G are two filaments having one end of each connected to the free ends of the columns F, while their other ends are connected to the cross piece E. In Fig. 1 the spindle is urged to rotate in one direction by a spring H, while in Fig. 2 the spindle is urged to turn in one direction by weights I attached to cords J wound upon a pulley K fast on the spindle. When an electric current is passed through the columns F they expand and turn the spindle against the spring or weights, and the movement of the arm D will give an indication of the extension of the columns or of the strength of the force causing such extension.—*July 3rd*, 1917.

107,647 (9539 of 1916). July 6th, 1916.—Apparatus for Measuring the Frequency of Electric Currents, Marconi's Wireless Telegraph Company, Limited, and another, Marconi House, Strand, W.C.

It is well known that when a voltage is applied across the hot and cold electrodes of a discharge device, such as a Fleming valve, the magnitude of the current flowing will, for the particular valve, be a function of the temperature of the hot electrode and of the applied voltage. If the temperature be kept constant while the voltage is made to vary, the current will vary with the voltage until this latter reaches a state of saturation, after which any further increase will not cause an increase in the current.

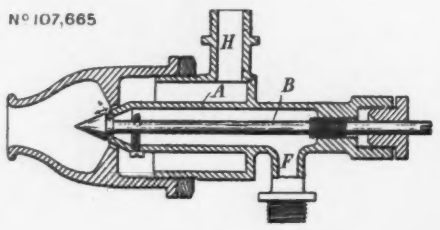


The inventors couple the oscillating circuit, the frequency of which they desire to measure, to a measuring circuit comprising a self-inductance or a condenser or both, and a limiting discharge device—such as a Fleming valve or a highly exhausted vessel with two hot electrodes—connected in series, and a voltage is applied across the limiting device in excess of that required for saturation. The voltage across the condenser, or the self-inductance, or both, will then be a function of the frequency since the current is constant, and a volt-meter may accordingly be directly calibrated in frequencies or wave lengths. In Fig. 1 A is the self-inductance in the circuit, B an inductance in series with C and two hot electrodes in an exhausted vessel D, across the inductance is a volt meter E, or the inductance C can be replaced by a condenser, as shown in Fig. 2.—*July 12th*, 1917.

LIGHTING AND HEATING.

107,665 (10,106 of 1916). July 18th, 1916.—Liquid Fuel Burners, Harold Newsom Davis and another, Diamond Foundry, Luton.

In this burner F is the fuel supply branch, H the air or steam supply branch, B a spindle adjustable horizontally by means of a screw thread, and having on its other end a conical extension piece. The tubular nozzle member A is cone-shaped at the

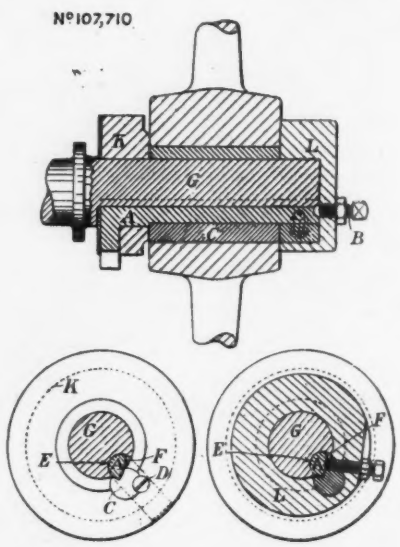


outward end and the general arrangement of the body, tube and seating is such that, while the fuel is sprayed outwardly, the steam or air converges, and the two are thoroughly intermixed before issuing from the apparatus. The inventors claim "A liquid fuel burner of the kind described comprising in combination an inner tubular nozzle member for the supply of fuel and having a tapering or outwardly flared outlet opening to deliver the fuel in a forward and outward direction and a frusto-conical end, an outer tubular member for steam or air, a nozzle adjustable on a outer tubular member and provided intermediate its ends with a diaphragm formed with a tapering opening to co-operate with a frustro-conical end of the inner nozzle member and deliver the steam in a forward and inward or converging direction, and an axially movable valve member of diamond, conical or other suitable form co-operating with and adjustable in relation to the opening in the inner nozzle member."—*July 12th*, 1917.

TRANSMISSION OF POWER.

107,710 (15,710 of 1916). November 3rd, 1916.—Clutch for Power Presses, Fred Wood, 5, Stanmore View, Burley Hill, Leeds.

This is an automatic positive clutch in which A is a spring-pressed rolling-pin with endwise adjustment B. C is a longitudinally-recessed key of cylindrical form held stationary in the hub by the grub screw D. One side of the recess in the key C has the same radius as the peripheral part E of the pin A, while the opposite side of the recess is made to the same radius F as the shaft G, which corresponds to the radius of the other side of the bolt A, so that when the latter is in active engagement with the

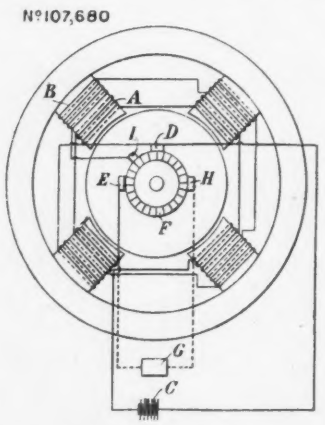


longitudinal key both sides of the bolt are in rubbing contact with the compound curved recess of the key. The key C is so situated that the edges of its compound curved recess are flush with the adjacent edges of the fly-wheel bush, which means that no portion of the key is in rubbing contact with the shaft G carried by the clutch collar K. A separate portion or extension of the cylindrical key is carried forward into the end collar L, so that the fly-wheel is free to be removed at will, while the end collar is fitted with an adjusting screw to bear against the rolling-pin or bolt A to lock it in engagement with the compound curved recess of the cylindrical key, and so enable the shaft to be rotated in the reverse direction when desired.—*July 12th*, 1917.

MOTOR CARS AND ROAD TRAFFIC.

107,680 (10,720 of 1916). July 28th, 1916.—Combined Starter and Lighting Dynamo, Albert Henry Midgley, and others, Warple Way, Acton Vale, Middlesex.

This invention is for a combined starter and lighting dynamo having a series and a shunt field excitation winding in which two commutator brushes of the same polarity are provided with an automatic cut-out inserted between them, one of these brushes being disconnected when the machine is running as a dynamo, preferably by its being moved away from the commutator. Referring to the arrangement illustrated, the field magnet of a four-pole machine is provided with series and shunt excitation windings A and B respectively, the positive pole of the battery C being connected to one commutator brush D, and the negative pole being connected through the series field excitation winding A to a commutator brush E, which is capable of being lifted off



the commutator F when required, and through the series field winding and the automatic cut-out G to another commutator brush H. The two brushes E and H are arranged diametrically opposite each other, and at 90 deg. relatively to the brush D which is connected to the positive pole of the battery. In order to obtain a constant output one end of the shunt field excitation winding B is connected to the positive brush D, whilst the other end is connected to a brush I, which is arranged between the positive brush D and the negative brush. When the machine is running as a motor, the movable negative brush E rests on the commutator F, whereby the automatic cut-out G is rendered inoperative, and the heavy starting current is prevented from passing through the same. When the machine is running as a dynamo, the movable negative brush is lifted off the commutator, thereby leaving the automatic cut-out in the circuit between the dynamo and the battery.—*July 12th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for The Engineer *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of five of the patents given below £26 *and on each of the remainder* £18 *have been paid in renewal fees.*

No. 23,255/10.—Small-arms; cooling barrels; stocks. Relates to rifles of the kind in which the barrel is enclosed in a perforated covered tube, and consists in the use of a perforated fluted tube so arranged that air space is provided between the tube and the barrel, and between the tube and the stock. The stock is preferably recessed and pierced. Mauser, P., Germany. Dated December 4th, 1909.

No. 23,278/10.—Making iron window frames. Iron bars for window frames are suitably cranked and cut for fitting together by acting on them with a tool and die. The die has a shape to correspond with the cranked portion, and the tool is partly wedge-shaped, and of a section to correspond with the section of the frame bar. The tool may have a part for punching a preliminary hole, and a part for cutting a slot in the web. Kopplinger, H., Vienna. Dated October 12th, 1909.

No. 23,457/10.—Braiding machines. Machines in which groups of two plates and a side track are spaced alternately by ordinary plates and Volkenborn switches, are provided with switches in addtion to the known switches and with bobbin-arresting devices. Treckmann, E., Germany.

No. 23,459/10.—Coke ovens. In horizontal coke ovens, the refractory bricks which form the walls of vertical flame flues are prevented from fusing by passing the air for combustion through passages formed in the flue walls, and by supplying this air at different levels in the heating flues, so as to extend the combustion zone. Still, C., Prussia.

No. 23,467/10.—Purifying oils, &c. Hydro-carbons, such as petroleum, benzol, and terpenes, are purified by mixing them with finely-divided carbon having catalytic properties, and bringing the mixture into intimate contact with oxygen, ozone, or gases containing oxygen. Impurities, especially those due to the presence of sulphur and nitrogen, are oxidised and carried away in the form of gases. Richter and Richter. Berlin. Dated May 12th, 1910.

No. 23,493/10.—Weighing apparatus; indicating and registering mechanism. A mirror is hinged to the frame of a weighing machine, so that the weight indicated on the dial may be read from above. Koch, F., Berlin. Dated May 28th, 1910.

No. 23,548/10.—Electrolysis; persulphuric acid, obtaining; electrodes. Anodes used in making this acid are cooled, say by water passed through them. Direct cooling of the electrolyte is then unnecessary, and good yields of the acid can be obtained without addition of hydrochloric acid or the like to the sulphuric acid employed. Consortium fur Elektrochemische Industrie Ges., Germany. Dated November 4th, 1909.

No. 23,559/10.—Gas producers. A grateless gas producer is provided with an external air supply, by means of an inwardly open hollow ring communicating with a box placed above it, and connected with the air pipe. The ring is divided into compartments by partitions, and air is admitted to the various compartments through slides arranged in the box, by means of which it is possible to regulate exactly the air supply over the entire periphery of the shaft. Frambs, H., and Bender and Frambs Ges., Germany.

No. 23,675/10.—Electric conductors; cables. Metallic coils of wire or bands, for instance, of aluminium, are coated with an insulating covering of oxide by subjecting such coils throughout their entire mass to a treatment with an oxidising gas, such as oxygen and steam, a fall of temperature and pressure being produced in different parts of the coil or of the vessel containing it. The steam may be at high pressure and may be produced in the vessel containing the wire. Kuttner, E. W., Berlin. Dated October 14th, 1909.

No. 23,847/10.—Feeding sheets. Relates to means for driving the conveying rollers of sheet feeding apparatus more slowly as the sheet approaches the front stops. Spiess, G., Germany.

No. 24,389/10.—Welding metals. In the butt welding of rails, bars, &c., by the thermit process, the two pieces of work are held in a clamping apparatus *in situ*, and the ends, which are in alignment, are faced to exact parallelism with each other by a milling or like apparatus. They are then cleaned and drawn together, the mould is applied, and the thermit is run in, the ends of the rails being pressed together by the screw clamps. To fill up a gap a piece of sheet metal may be inserted before welding. The work may be initially heated to redness by a charcoal fire, either before or after the mould has been applied, or this heating may be accomplished by passing hot gases through the mould. A mould of considerable thickness, made in two or more parts, may be used, having a bridge for dividing the ring of thermit at the bottom of the rails, &c., into two parts to facilitate its removal. Goldschmidt, T. (firm of), Germany. Dated October 26th, 1909.

The South-Western Polytechnic Institute.—The Michaelmas term of the South-Western Polytechnic Institute, Manresa-road, Chelsea, S.W. 3, commences on September 24th; the enrolling evenings being those of the 19th, 20th and 21st of that month, when the Institute will be open from 7 to 9 p.m. In this Institution there are departments devoted to mathematics, physics, mechanical and electrical engineering, chemistry and metallurgy, natural science, art, domestic science, &c. We notice that in that devoted to mechanical engineering there is to be a course of lectures on aeronautical engineering, and that in the chemistry department research is being undertaken for war purposes, so that a good opportunity is afforded for those who desire to become practically acquainted with modern methods of research. Another interesting point may be recorded. Disabled soldiers and sailors are to be admitted to any classes that may be suitable for general training, and special courses may be formed in technical subjects in connection with the arrangements that are being organised by the London County Council Education Offices.

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VOL. CXXIV.—No. 3217] LONDON: FRIDAY EVENING, AUGUST 24, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

UNIVERSITY OF DURHAM.

Armstrong College, Newcastle-upon-Tyne.

PRINCIPAL: W. H. HADOW, M.A., D. Mus., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—
F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M. Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE, comprising FACULTIES OF ENGINEERING AND METALLURGY.

PROFESSORS IN THE DEPARTMENT.

Mechanical Engineering	W. RIPPER, D.Eng., M. Inst. C.E.	D.Sc.,
Metallurgy	J. O. ARNOLD, D.Met., F.R.S.	
Mining	F. E. ARMSTRONG, A.M. Inst. C.E.	M.Sc.,
Applied Chemistry	L. T. O'SHEA, M.Sc.	
Mathematics	A. H. LEAHY, M.A.	
Physics	S. R. MILNER, D.Sc. (Acting Prof.)	
Chemistry	W. P. WYNNE, D.Sc., F.R.S.	
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Electrical Engineering	E. H. CRAPPER, M.I.E.E (Lecturer).	B.Eng.,
Civil Engineering	J. HUSBAND, Inst. C.E. (Lecturer).	B.Eng., A.M.
Glass Technology	W. E. S. TURNER, (Lecturer).	D.Sc.

The subjects in which courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes courses in Civil, Mechanical, Electrical and Chemical Engineering, and students specialise in one or other of these branches in the third year of their course. The course in Engineering extends over three years, and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' courses are arranged for Works' Pupils, who come to the University from works in Sheffield, or from other centres, taking six months' study at the University and six months' practice at the works each year.

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Part Time Courses are arranged for students who desire to take special portions of any of the regular courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917.

W. M. GIBBONS,
Registrar.
139

University of Manchester.

DEPARTMENT OF ELECTRICAL ENGINEERING.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Full particulars of these Courses will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on the 4TH OCTOBER. 411

Ashton-under-Lyne, Stalybridge AND DUKINFIELD (DISTRICT) WATERWORKS.

The Joint Committee REQUIRE the SERVICES of a thoroughly capable and energetic ENGINEER to take the entire charge and management of the Out-door Department of their Undertaking.

The area of supply is about 33,470 acres, and includes four Municipal Boroughs and two Urban District Councils within their Contributory district, and several adjoining Urban Council Districts within their non-contributory district, the population of the whole being about 140,000.

There are twelve impounding and service reservoirs situate in different districts having total capacities of nearly 1050 million gallons.

Applicants must have had considerable experience in the preparation of plans, estimates and reports of work required, superintending the laying of mains and services and control of men, together with experience of the latest systems of mechanical pressure filters.

Applications, stating age, salary, experience, &c., and enclosing copies of three recent testimonials, to be sent to the undersigned not later than the 5th day of September, 1917, endorsed "Engineer." Canvassing prohibited.

LEES BUCKLEY,
Secretary.

Waterworks Department,
Town Hall Chambers,
Ashton-under-Lyne.
10th August, 1917. A

Commissioners for the Port of RANGOON.

FOR SALE:—TWIN SCREW, STEEL, SELF-PROPELLING SUCTION DREDGER, "PELICAN," and FLOATING PIPE LINE, built by Messrs. W. Simons and Company, Renfrew, 1906.

DREDGER.—Length 206ft. by 36ft. beam; maximum draught 10ft. 7in.

Two sets triple expansion surface condensing propelling and two sets pumping engines, with 4 boilers; two 30in. centrifugal pumps with nominal capacity of 20,000 cubic feet of sand or silt per hour, lifting from a depth of 35ft. and delivering through 3000ft. of pipe line.

FLOATING PIPE LINE.—In 58 lengths of steel pipe, 50ft. long and 42in. diameter, on circular steel pontoons, 26ft. diameter and 4ft. 4in. deep.

Further particulars may be obtained from
The SECRETARY,
Commissioners for the Port of Rangoon,
Post Box No. 85,
Rangoon, Burma. 520

Wanted, Steel Foundry

MANAGER where stock fuel oil and Snyder electric furnaces are in use. State experience and salary required.—Address, 531, "The Engineer" Office. 531 A

Electrical and Mechanical Engineer

ACCUSTOMED to laying out plant for rolling mills, wire drawers, &c., and able to make own plans. State age, experience, and wages required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and No. A3681. P918 A

Electrical Power Engineer, with

experience in A.C. and D.C. Motor Factory Equipments, preferably with drawing-office or test experience, for large manufacturing firm (controlled).—Apply, stating experience, age, and salary required, to your nearest Employment Exchange, and quote "The Engineer" and No. A3537. No person already engaged on Government work need apply. 511 A

Engineer's Buyer Wanted. Pre-

FERENCE given to one having experience in Locomotive and Light Railway Work, also Estimating (he would be required to deal with all shop orders and material). Only competent, experienced men need apply, and no person already on Government work will be engaged.—State experience, age, and salary required to your nearest Employment Exchange, quoting "The Engineer" and number 468. 468 A

Engineer Required for Midlands,

to Fix Prices and Time Allowances for General Production. Must be experienced on piece-work and bonus system, and able to plan operations correctly; state salary. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 532. 532 A

Machine Shop Foreman Re-

QUIRED in large Engineering Works, Manchester district, to take control of Department employing 150 hands, at present engaged on Gun Manufacture. Prospects good. Only experienced men and those not engaged on Government work need apply.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3580. 525 A

First-class Experienced Esti-

MATOR WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Head Electrical and Mechanical

ENGINEER (ineligible) WANTED for large Textile Mill in Spain (Barcelona district); good A.C. and D.C. experience and general mechanical knowledge essential, also accustomed to control of men. State age, experience, and salary required.—Address, 509, "The Engineer" Office. 509 A

Jig and Gauge Inspector Wanted

at Controlled Factory in the Midlands. Only first-class men and those not already engaged on Government work will be considered.—Apply, at your nearest Employment Exchange, quoting "The Engineer" and reference No. A3563. 508 A

Manager Wanted for the Mid-

LANDS, thoroughly competent to UNDERTAKE CONTROL of the Manufacture of Milling Cutters, Reamers, Hobs, Gear Cutters, &c., of all descriptions, from the blank to the finished tool. Must be experienced in handling both male and female labour, able to fix rates, and capable of introducing the most up-to-date methods of production.—Write, stating full details of experience, also age, and salary expected, to U.G.C., c/o Streets, 30, Cornhill, E.C. 3. 519 A

Rate Fixer Wanted for Engine

Works. Accustomed to modern machine methods for medium and heavy classes of work. Apply with full particulars as to experience and wages expected. Good opening for experienced man. No one already on Government work need apply.—Apply your nearest Employment Exchange, mentioning "The Engineer" and No A3567. P921 A

Required, a Thoroughly Experi-

ENCED working charge ENGINEER for a Roofing Felt and Asphalte Factory. One with a good general millwright's experience preferable. The appointment is for a permanency. Adequate assistance is given, all light repairs being executed in an equipped small engineering shop in the factory. Position East End of London. Applicants must show first-class credentials and be unquestionably experienced.—Address, in the first place, with full particulars as to capabilities, 502, "The Engineer" Office. 502 A

Research Physicist Wanted for

large Scientific Instrument Factory. Graduate in Science, with workshop experience preferred.—Reply, stating age, salary, and full details of experience, to 480, "The Engineer" Office. 480 A

Russia.—Required for General

Engineering Works (Munitions) CAPABLE MAN to take entire charge Drawing-office. Able design, construct independently. Thorough knowledge machine tools (especially boiler making tools) essential. Previous Russian experience advantage.—Address, fullest particulars to P909, "The Engineer" Office. P909 A

Young Mechanical Engineer

WANTED by Controlled Establishment, must have sound practical and technical experience. A knowledge of metallurgy or chemistry would be an advantage, but is not essential. No one on Government work can be engaged without consent of their present employers.—Reply, giving full particulars, to nearest Employment Exchange, mentioning "The Engineer" and number 528. 528 A

Wanted, Confidential Clerk for

Manager's Office, large engineering firm in Manchester district. Good stenographer, accustomed to engineering terms. Up-to-date office arrangements, &c. No one already on Government work will be engaged. State age, full details of experience, and salary required.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3566. 497 A

Wanted for the Electrical Engi-

NEER'S Dept. of a large Steel and Iron Co. in the North Midlands, several good DRAUGHTSMEN who have had experience in the design of E.H.T. and H.T. Substations, and the layout and installation of motors, cables, switchgear, and special appliances in connection with the driving of heavy Steel Works or other similar plant engaged on varied classes of War work. Applicants are requested to give their age, and submit references and details of their training and experience, also to state the wages required, and the earliest date upon which they could take up their duties if selected for the post. No person already employed on Government work will be engaged.—Apply, nearest Employment Exchange, mentioning "The Engineer" and number 463. 463 A

Draughtsman, Junior, Mechan-

ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234. 12 A

Draughtsman (Mechanical or

Electrical) REQUIRED in London (West) by a firm of Engineers engaged on Admiralty work. No one living more than ten miles away or already employed on Government work will be engaged. State age, experience and salary required.—Address, 435 "The Engineer" Office. 435 A

Draughtsman, Mechanical, One

used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 A

Draughtsman Required for

service in an Admiralty Department, preferably with experience of Marine Engineering.—Applicants to state age, salary required, and details of previous experience (by letter only) to Box No. 1194, c/o Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C. 4. 521 A

Draughtsmen Wanted, Tho-

ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Appiy your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 A

Draughtsman Wanted, with Good

Mechanical and Electrical experience, for large Paper Mill near London; permanency, with excellent prospects for right man.—Address, 530, "The Engineer" Office. 530 A

Jig and Tool Draughtsman Re-

QUIRED at once in Government Controlled Establishment. Good opening for right man. Application, accompanied by full particulars of experience, age, and salary required, must be made through the nearest Employment Exchange, mentioning "The Engineer" and number 491. 491 A

Jig and Tool Draughtsman

REQUIRED by leading firm of Sheet Metal Workers in Birmingham area. Experience in the production of aircraft parts desirable. Permanent position for the right man. No person already on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3516. 510 A

Mechanical Engineering

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Wanted, for an Important

Hydraulic Pumping Installation in South Wales, competent CHARGEMAN ENGINEER. Only men who have had experience of a similar capacity in a first-class station need apply. Must be ineligible for military service.—Address, stating age, qualifications, past experience and salary required, to 428, "The Engineer" Office. 428 A

Crankshafts.—An Experienced

FOREMAN REQUIRED to take charge of Machine Shop dealing with small crankshafts. Only men having previous experience in crankshaft turning and grinding need apply, stating age, references, and salary required. No one at present on Government work need apply.—Apply your nearest Employment Exchange, quoting "The Engineer," and number 518. 518 A

Foreman Electrician Wanted by

Engineering Works; must be used to high-tension wiring of all voltages and upkeep of plant, both alternating current and direct current. No person already on Government work will be engaged.—Apply, with references, to your nearest Employment Exchange, and mention "The Engineer" and No. A3542. 402 A

Wanted, an Improver for Turn-

ING Rolls for light Rail Mill.—Address, stating rate of wages required and when at liberty, to 445, "The Engineer" Office. 445 A

Chiltern Hills Spring Water Co., AYLESBURY.

WANTED, skilled LABOURER for Repairing Mains, in Tring district, and to assist in repairs to deep-well pumps, cleaning out boilers and reservoirs; also work general to Pumping Station.

House, garden and coal provided at Dancers End Station.

Applicants must state wages required together with age and qualifications.

P915 A H. A. CALLON, Manager.

Engineer's Fitter (Ineligible for

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Good Turner Wanted for Govern-

MENT WORK; must be used to micrometer. No one already engaged on Government work need apply.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3596. P932 A

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QUIRED to do work of national importance, DESIRES ENGAGEMENT. Engineering Student at Birmingham University for two years; Public School education.—Address, P895, "The Engineer" Office. P895 B

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Constructional Engineer and

MANAGER, shortly to be disengaged, SEEKS APPOINTMENT; 10 years' experience on public works contracts; all branches of constructional works; used to dealing with large numbers of men and all kinds of contractor's machinery. Now employed constructing railways at one of H.M. munition factories (contract shortly terminating).—Address, 299, "The Engineer" Office. 299 B

Engineer and Draughtsman

(Mechanical) DESIRES CHANGE. Ten years' shop and D.O. experience.—Address, P925, "The Engineer" Office.

Engineer and Expert Draughts-

MAN, undertake Spare Time Detail and Design Work for engineers and manufacturers in London. Specialist—pumping, hydraulic, and general machinery.—Address, P915, "The Engineer" Office. P915 B

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POSITION with London firm on Government work. General and steam plant, D.O., works, estimating, sales and correspondence; can introduce new business.—Address, P916, "The Engineer" Office. P916 B

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thorough practical, technical, works management experience in general engineering, REQUIRES RESPONSIBLE WORK. Commencing salary £300.—Address, W., 493, Chatsworth-road, Chesterfield. P899 B

Rate Fixer, Five Years' Experi-

ENCE in heavy and light munition work (holding clearance), 23 years' practical engineering, SEEKS POSITION of TRUST. Change of work desired.—R. H., 123, Rochdale-road, Plumstead, S.E. 18. P926 B

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Manager of a highly successful Aircraft Firm DESIRES CHANGE. Thoroughly experienced in practical, theoretical, and commercial engineering. Could obtain an excellent staff for a new firm starting. Have built the latest flying boats, seaplanes, and hand machines. Can prove capabilities by past results.—Address, in strict confidence, P906, "The Engineer" Office P906 B

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POSITION. Keen, energetic, good technical education. Highly experienced in steam engines, pumps, hydraulic and electrical work. Used to control of men. Excellent refs.—Address, P910, "The Engineer" Office. P910 B

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controlling 1600 workers in manufacture of Motor Vehicles and Shell, SEEKS ENGAGEMENT with first-class firm; several years' experience in light and heavy work with some of leading firms in Britain.—Address, P928, "The Engineer" Office. P928 B

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OPEN for ENGAGEMENT General Engineering; 12 years' works management; internal combustion engines; male and female labour.—Address, P924, "The Engineer" Office. P924 B

Secretary-Accountant Desires

POSITION; 16 years' experience motor and aeroplane trades; 7 years secretary Motor Company; thoroughly capable and energetic. Book-keeping, balance sheets, correspondence and buying. Good organiser, disengaged, age 39.—N., 28, Casselden-road, Harlesden, N.W. P911 B

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DESIRES OUTDOOR EMPLOYMENT, 12 years shop and D.O. experience.—Address, P920 "The Engineer" Office. P920 B

Tracer (Lady), 12 Years' Experi-

ENCE, Gun Work, SEEKS POSITION.—Address, P931, "The Engineer" Office P931 B

Foreman Patternmaker, Just

over military age, WANTS SITUATION as above, or would Take Charge of small Iron Foundry as well. Thoroughly capable and up to date, and conversant with foundry practice in all its branches. Many years last situation.—Address, P914, "The Engineer" Office. P914 B

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HAVE an OPENING for a YOUTH of Good Education as PREMIUM PUPIL, the course to include both Works and Drawing-office.

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Postal Courses in Mechanical Engineering, also A.M.I. C.E., and A.M.I M.E. Introductory Course in Engineering Mathematics and Mechanics.—254, Oxford-road, Manchester. 2018

Inst. C.E., Inst. Mech. E., B.Sc.,

and all ENGINEERING EXAMINATIONS.—MR. G. P. KNOWLES, B.Sc., A.M.Inst.C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Hundreds of successes during the past twelve years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. 238 B

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Address, 6, "The Engineer" Office. 6 D

Machine Tools — Advertiser,

with London Office and extensive connection, DESIRES to REPRESENT FIRM who have Ministry permit to handle Machine Tools.—Address, P933, "The Engineer" Office. P933 D

Engineering.—Partnership

WANTED by Advertiser, with Commercial and Practical experience, or would Purchase Business. Cash available up to £4000, but prefer smaller investment. District no object. Undeniable references.—E., H. S. Baker and Co., Chartered Accountants, 5, Broad-street-place, London, E.C. P934 C

PARTNERS
DIRECTORS
BUSINESSES
FACTORIES
for these apply to
WHEATLEY KIRK, PRICE AND CO.,
46, Watling-street, LONDON, E.C.
Albert-square, Manchester.
26, Collingwood-street, Newcastle-on-Tyne. Sp 3008

SMALL ADVERTISEMENTS

SITUATIONS, FOR SALE, &c.,
PAGES II., III., LXXXII.

Numerical Index to Advertisements,
PAGE LXXXI.

Managing Partner Wanted, in place of Partner wishing to take less active part, in Engineering and Ironfounding Business in West Riding Town. —Address, for particulars, 420, "The Engineer" Office. 420 c

The Directors of a Government controlled Firm of Engineers who have overtaxed their resources in the introduction of new specialities, would WELCOME FINANCIAL and COMMERCIAL HELP. Fullest investigation courted to principals only.—Address, 501, "The Engineer" Office. 501 c

Wanted, Steam Generating Set, 40 to 60 K.W., 220 volts, suitable for boiler pressure of 80 lb. and back pressure of 20 lb. per sq. inch. State full particulars, price and where can be seen.—Address, 507, "The Engineer" Office. 507 r

Wanted, Supply of Hoffmann Standard type BALL-BEARING HANGER for 2¼in. haft. Either new or good second-hand.—Address, stating price and full particulars, to 503, "The Engineer" Office 503 r

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.R., Smith's Agency, Ltd., 100, Fleet-street, E.C 1 r

Wanted, 6 B.H.P. Oil Engine for Electric Lighting.—Full particulars to 512, "The Engineer" Office. 512 r

Steam Navvy Wanted to go to work immediately. About 1½ yards capacity. State maker's name, date, full particulars, and lowest price.—Address, 426, "The Engineer" Office. 426 r

200 K.W. Shunt Wound Dy- NAMO WANTED immediately, 380 volts, 160 r.p.m., for direct coupling or high-speed three bearing.—Send full particulars, GIRLING Maldon, Essex. 496 r

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c. 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground Street, London, S.E. Telephone No. 978 Hop. 822 c

For Immediate Sale, 600 H.P. VERTICAL QUADRUPLE EXPANSION ENGINE, by J. Musgrave and Sons, Bolton; steam pressure 200 lbs.—Full particulars from J. BIBBY and SONS, Waterloo-road, Liverpool. 441 c

FOR SALE,
Large Quantity YORKSHIRE and other GAS COKE.
THOS. DUXBURY and CO.,
N128 Grosvenor Chambers, Manchester.

For Sale :—

PARSONS STEAM TURBINE, 3500 K.W., 1200 r.p.m, 200 lb. to sq. in., with alternator field-rotating type and exciter, complete; 4000 volt maximum load; 40 cyls.

One 600 K.W. GENERATING SET, Engines by Bellis and Morcom, Ld.; cyls. 16½in. and 23in. × 42in. stroke. "Parker" Generator, 500 volts D.C. Complete with surface condenser, motor-driven pumps, &c.

One 125 K.W. Ditto ALTERNATOR by Ferranti, Ltd., 2000 volts, 50 periods. Vertical Cross Compound Engine, 250 H.P., by J. and H. McLaren.

One 200 K.W. SET, Engine by Bellis and Morcom; cyls. 9in. and 14in. × 12in. stroke; direct-coupled to Crompton's dynamo, 500 volts D.C., 380 r.p.m.; 120 lb. steam.

GENERATING SET, 125 K.W., with 250 H.P. Vertical Cross Compound Condensing Engine.

ALTERNATOR, by Ferranti, Ltd., 2000 volts, 50 periods A.C.

PAIR CROSS COMPOUND ENGINES, 600 H.P., 26in. h.p. cyl., 40in. l.p. cyl., 4ft. stroke, Corliss valves to h.p. cyl., slide valve to l.p. cyl., fly-wheel 20ft. dia., by Barclay, Sons and Co., Ltd.

CROSS COMPOUND HORIZONTAL ENGINE, 14in. h.p. cyl., 22½in. l.p. cyl., 36in. stroke, 12ft. dia. fly-wheel, by Davy, Paxman and Co.

R. H. LONGBOTHAM & CO., Ltd.,
WAKEFIELD,
& AT MILBURN HOUSE, NEWCASTLE-ON-TYNE.
Tel.: 44 Wakefield; 867 Newcastle.
Tel. Add.: "Engineer, Wakefield." 2017 c

For Sale :—
Quantity good SECOND-HAND 18in. gauge
PORTABLE RAILWAY
complete with Two TURNTABLES and Three Sets POINTS and CROSSINGS to suit. 15 Set 24in. Gauge Points and Crossings, new C.I. Turntables, 24in. gauge. Sleepers, Crossing Timbers, and Fit Timber.
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Market-place-buildings, High-street, Sheffield. Spl 3008

For Sale :—

Two LANCASHIRE BOILERS, each 28ft. × 7ft. for 180 lb. working pressure, complete with Hopkinson stokers. Quick delivery.

A 100/110 K.W. steam-driven ELECTRIC GENERATING SET; engine by Willans; dynamo by Electric Construction Company; 400-430 volts, or would sell engine without dynamo.

Three power-driven BOLT SCREWING MACHINES, up to 2in.

Several LATHES, 8in. to 16in., requiring slight repairs.

Horizontal BORING MACHINE, with rising table 6ft. × 2ft.

Two Sets of 4-Ton LIFTING TACKLE for running on joists; all motions by hand.

One Set of 5-Ton ditto.

One Set of 7-Ton ditto.

GEO. COHEN, SONS AND CO.,
600, Commercial-road,
London, E. 14. 2012 c

For Sale, a Bargain (to Save Second Removal), 225 K.W. GENERATING SET, comprising Bellis-Morcom Compound Engine and Crompton Multipolar Generator, 400-440 volts, with switch panel and cables, in perfect condition.

Also 400 H.P., 460 volt, D.C., single-bearing GENERATOR or MOTOR, by Dick, Kerr & Co.; speed 375 r.p.m.

Both the above are open to any inspection at Coventry, and can be put on rails at once

Apply, FRANK GILMAN, Lightwoods Hill, Birmingham Telephone: Edgbaston 1081. 533 c

For Sale, Blower, 5in., with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1703 c

For Sale, Boilers.—
CORNISH BOILER, 22ft. × 6ft., 90 lb. steam.
Do. Do. 24ft. × 5ft. 6in., 100 lb. steam.
Do. Do. 16ft. × 6ft., 100 lb. steam.
ECONOMIC BOILER, 14ft. by 9ft., 100 lb. steam.
LANCASHIRE BOILER, 24ft. by 7ft., for 120 lb. steam, no cross tubes, by Adamson.
LOCOTYPE, 30 H.P., by Robey, 100 lb. steam.
All immediate delivery.
A. UNDERWOOD, 3, Queen-street, E.C. 538 c

For Sale, Capstan Winch, Pair 7in. cyls., 2 drums, by Joseph Evans.—A. UNDERWOOD, 3, Queen-street, E.C. 539 c

For Sale, Motor Generator, by the G.E.C., 500 volts, 225 amps., with two-series wound boosters, 110 volts, 410 amps., 650 r.p.m., 6-pole type; seen running.—WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. 4. 475 c

For Sale, Four Sets of Standard type (Style 5) Babcock and Wilcox Pattern Improved MECHANICAL CHAIN GRATE STOKERS. Each set suitable for land type boilers on 6000 square feet of heating surface and 20,000 pounds of evaporation per hour when dealing with ordinary slack coal, fitted with 4-speed gear and the usual accessories. These are in good working order, and are at present on regular service load.
R. H. LONGBOTHAM and CO., Ltd.,
Wakefield. 516 c

For Sale, Hauling or Winding ENGINE, by Schram, self-contained on steel frame; drum 2ft. 6in., cyls. 6 by 9. Also TWO WINCHES, by Holman 4½ by 7½.—A. UNDERWOOD, 3, Queen-street, E.C. 4. 537 c

For Sale, Metal Pipes; About 70 ton C.I. Spigot and Socket Pipes, 8in. by 9ft. by 9/16in.—Apply, JAMES WATERSON, 40, Waring-street, Belfast. 400 c

For Sale or Hire, Electric MOTORS, from 4 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-Street, London, E.C Tel.: City 3938, 2025 c

For Sale, Plate Edge Planing MACHINE, 20ft.; Ditto, 16ft.
Engine driven 2in. PLATE SHEARING MACHINE, 8ft. blades.—Address, 500, "The Engineer" Office. 500 c

For Sale, Second-hand Pumps:—
Vertical 3-throw, 7½in. gun-metal plunger; engine driven; 10,000 gallons; by Hayward-Tyler.
Horizontal Compound Duplex, cyls. 10in. and 16in. dia.; 8in. G.M. plungers; 200 lb. pressure.
Hor. Tangye, 21in. × 12in. × 36in. stroke.
Vert. Fearn, double ram; 7in. plungers.
Ditto ditto, 4in. plungers.
Two Vert., belt driven, geared; 6in. G.M. plungers.
10in. Gwynne's Centrifugal; engine driven.
Steam Fire Pump (Shand-Mason); three 8½in. cyls.; G.M. pump, 8in. buckets, and 5in. plungers.
Others, all sizes, in stock.
—WILLIAMS and SONS, South Barmondsey Rly. Station, London, S.E. 16. 375 c

For Sale, Stone Breakers, 22 by 11, 16 by 10, Baxter, knapping motion; also 20 by 10, Broadbent.—A. UNDERWOOD, 3, Queen-street, E.C. 541 c

For Sale, Theodolites,
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(opposite Gray's Inn-road).

For Sale, Levels,
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(opposite Gray's Inn-road). 2003

For Sale, Two Pulley Blocks (makers, Rowland Priest, Cradley Heath) for hemp rope, London pattern, galvanised wrought iron, fitted with swivel ring, gun-metal double sheave 10in. dia. by 2in. width of groove, tested to 192 cwts. Two do. do. gun-metal single sheave 10in. dia. by 2in. width groove, tested to 110 cwts. Cost £14 5s. prior to the war. Quite new.—Send written offer to D. E. R., c.o. Streets, 30, Cornhill, E.C. 3. 535 c

For Sale, Winding Engines, Pair 10in. cyls., 18in. stroke, with two drums, 4ft. 6in. diam., by Hofman.—A. UNDERWOOD, 3, Queen-street, E.C. 540 c

For Sale, 30 B.H. Hornsby Gas ENGINE and SUCTION PLANT, 150 amps., 110 volts, direct current dynamo, switchboard, magnetic ignition, four years old, good order, can be seen running.—Apply, NATIONAL MOTOR CAB CO., Ltd., 134, King-street, Hammersmith, W. P908 c

For Sale.—32-Ton Hand Travel- LING CRANE, 42ft. span, girder type, double chain.
35 H.P. Type "U" CROSSLEY GAS ENGINE.
Apply, DAVIES and METCALFE, Ltd., Romiley. 10 c

For Sale, 110 K.W. Steam GENERATING SET, Siemens type Dynamo, 220 volts, 500 amps., 350 r.p.m.; immediate delivery.—WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. 476 c

For Sale, 130 H.P. Motor, by G.E.C.; 500 volts, 225 amps., 650 r.p.m.; 6-pole machine; now fixed; immediate delivery.—WILLIAMS and SONS, South Barmondsey Rly. Station, London, S.E. 16. 374 c

Four "B" Type Mechanical STOKERS, by the Underfeed Co., for 3ft. diameter furnaces, complete with closed ashpits for forced draught, shafting, pulleys, and the necessary brackets for carrying same, also numerous spare parts.
Two Babcock and Wilcox WATER-TUBE BOILERS; evaporative capacity, 7000 lb. of water per hour; heating surface 2010 sq. ft. each; complete with Crosthwaite furnaces and superheaters; insured 160 lb. steam.
All above ex Power Station, in excellent condition and available immediate delivery, WESTERN ENGINEERING COMPANY, Swansea. 19 c

Generating Plant for Immediate DISPOSAL, comprising three Scott and Mountain-Mather and Platt Steam-driven compound-wound Generators, working at 120 lb. pressure and generating 440 amps. at 220 volts; speed, 350 r.p.m. The above may be seen running on load by appointment.—Address, 495, "The Engineer" Office. 495 c

Hydraulic Baling Press for Sale, suitable for Heavy Drapery.—DRAWBARN and SONS, Market-place, Wisbech. P935 c

Hydraulic Riveter, 100 Tons capacity, 8ft. gap, in working order. Also PUMPS suitable for above.—Apply DAVIES and METCALFE, Ltd. Romiley. 3 c

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Oil Engine, Hornsby, Working load 28 B.H.P., for SALE (unused). — NEWSOME, Besford Court, Worcestershire. 529 c

FOR SALE BEFORE REMOVAL.
One "Mirrlees-Watson" Con- DENSER, with Separator, capacity 30,000 lb. steam per hour, 3600 sq. feet cooling surface.
MOTOR DRIVEN SINKING FAN, by Waddell, capacity 20,000 cu. ft., motor 25 H.P., 500 volts.
R. H. LONGBOTHAM and CO., Ltd.,
Wakefield. 517 c

FOR SALE.
3ft. 6in. Gauge Four-Wheel- Coupled SADDLE TANK LOCOMOTIVE (Hudswell, Clarke), with outside cylinders 7in. diam. by 12in. stroke, copper firebox, brass tubes.

16-Ton STEAM DERRICK CRANE (Rasselin), with 54ft. split timber jib, 27ft. steel mast, timber guys and sleepers.

3-Ton STEAM DERRICK CRANE (Cameron), with 65ft. split timber jib; vertical boiler, 7ft. 3in. by 3ft., for 80 lb. steam working pressure.

2-Ton STEAM DERRICK CRANE (Butters), with 41ft. split timber jib, 25ft. timber mast.

30-Cwt. STEAM DERRICK CRANE, with 36ft. split timber jib; vertical boiler, 7ft. by 2ft. 9in., for 70 lb. working pressure.

15-Ton STEAM GUY CRANE (Balmforths), with 40ft. steel latticed jib, 32ft. steel mast; vertical boiler, 8ft. 6in. by 3ft. 6in. for 75 lb. working pressure.

CATALOGUE of Stock MACHINERY, 2-3000 Lots, free on application. Inspection invited.
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Two Eight-wheeled Four-coupled, 2-4-2 type, side tank main line LOCOS., 17in. cylinders, being rebuilt ... each £2500
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STEAM LOCOMOTIVE CRANES.

5-Ton STEAM LOCO. CRANE, by Isles, all motions £700
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5-Ton " " " by Stothert and Pitt, all motions £600
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5-Ton LOCO. CRANE, by Rushworth, as new, 4ft. 8½in. gauge ... £700
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Two 25-Ton Hand-operated TRAVELLING GOLIATH CRANES, 40ft. span, good condition ... each £300

STEAM NAVVIES.

10-Ton Whittaker Crane Type STEAM NAVVY ... £900
10-Ton Wilson Crane Type STEAM NAVVY ... £960
Two 12-Ton Wilson Crane Type STEAM NAVVIES. Rebuilt ... each £1250
Modern 10 H.P. Ruston-Proctor Tower Type NAVVY, fine machine ... £750
10 H.P. Ruston-Proctor Tower Type NAVVY ... £500

JOHN FREDK. WAKE, DARLINGTON.
513 c

Hydraulic Machinery:

800 H.P. PUMPING ENGINE, by Hick-Hargreaves, Corliss valves, pumps for 2½ tons pressure per square inch.
Worthington COMPOUND PUMP, cylinders 12in. and 20in. × 15in. stroke, 160 lb. steam pressure, rams 4½in. diameter for 1500 lb. pressure ... £250
Fielding and Platt HYDRAULIC PUMP, steam cylinders 16in. × 18in. stroke, rams 13in., for 1500 lb. pressure ... £110
Belt-driven three-throw HYDRAULIC PUMP, 3½in. plungers ... £66
HYDRAULIC ACCUMULATOR, 5in. ram, 10ft. stroke, steel casing ... £110
Three Hydraulic Single-end PUNCHING and SHEARING MACHINES, by Fielding and Platt.
Horizontal HYDRAULIC PRESS, by Berry, Leeds, 11in. ram, 2ft. 8in. stroke, 3ft. cylinder ... £180

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Two 30ft. × 7ft. 6in. Flat End BOILER TANKS each £180
One 45ft. × 5ft. 6in. Egg End BOILER TANKS ... £110
A number of CYLINDRICAL and RECTANGULAR TANKS for liquids and air. Particulars on application.

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Special 300ft. series TANGYE PUMP, cylinder 14in., pump 10in., stroke 24in., suction 10in. £90
Evans SINKING PUMP, cylinder 12in., pump 7in., stroke 12in., suction 5in. Price ... £180
Four PULSOMETER PUMPS.
Six CENTRIFUGAL PUMPS, 4in. to 8in. outlets, belt and engine driven. 514 c

JOHN FREDK. WAKE, DARLINGTON.

Bulldozing Machine:

Very powerful long stroke BULLDOZING MACHINE £200
515 c

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(Normal and Narrow Gauge):

40 large 12-Ton HOPPERED WAGONS, bottom doors ... each £75
103 TEN-TONNERS, sides failing full length, rebuilt ... each £75
100 10 Ton GOODS WAGONS, side doors ... each £60
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The above wagons have laminated Spring Buffers, are thoroughly overhauled for works purposes; also
Number of 10 and 12-Ton MAIN LINE WAGONS for Coals, Goods, &c. Enquiries solicited.
25 10-Ton COVERED VANS for Main Line ... each £100
Three 10-Ton Rectangular TAR TANK WAGONS for Main Line ... each £135
40 3ft. gauge SIDE TIP WAGONS, with steel tops, oak underframes, rebuilt ... each £21

JOHN FREDK. WAKE, DARLINGTON.
516 c

10-Ton Steam Travelling Crane, second-hand, by Dunlop, Bell and Co. Fixed jib 17ft., 10ft. railway gauge.—For further particulars, WILLIAM FIRTH, Ltd., Greek-street, Leeds. 494 c

90 K.W. Steam Generating Set; high-speed enclosed engine, coupled to multipolar generator, 500 volts D.C. For immediate delivery.—HARRY H. GARDAM and CO., Ltd., Staines. 1343

500 B.H. Vertical National Gas ENGINE, coupled to 300 K.W. Siemens Alternator. Single phase, 25 cycles, 110 volts, and 135 K.W. D.C. Generator, 130 volts. 450 H.P. VERTICAL WESTINGHOUSE GAS ENGINE, 8 cylinder tandem coupled to Crompton 300 K.W. Alternator, single phase, 25 cycles, 110 volts. The two sets are arranged to work in parallel and can be seen running by appointment.—LAKE and ELLIOT, Ltd., Braintree, Essex. 498 c

1400 K.W. Steam Generating SET, comprising Bellias Triple-Expansion ENGINE, 2400 H.P., coupled to Alternator, 6000-6400 volts, 50 cycles, 3-phase. Has done about two years' work only; in first-class condition and for immediate delivery.—Full particulars from HARRY H. GARDAM and CO., Ltd., Staines. 1343a c

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PROMPT DELIVERIES.
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MANUFACTURERS OF THE
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MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES, CARRIAGE AND WAGON IRONWORK, also CAST STEEL AXLE-BOXES. 492

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to British, Colonial, India-office Specifications, &c.
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Sheffield.
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National Telephone No. 4680 (3 lines). 863

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With Cast or Hydraulic Forged Naves.
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Makers of WHEELS, AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, and IRON and BRASS CASTINGS.
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Cardiff Office: Gordon Chambers, 31, Queen Street.
London Office: 14, Londenhall Street E.C.
See Illustrated Advt this week, page 41 no667

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CLUTHA WORKS, GLASGOW
Manufacturers of RAILWAY WAGONS and CARRIAGES, IRON and STEEL SLEEPERS, FISH-BOLTS, SPIKES, and other PERMANENT WAY MATERIAL, BRIDGES, and ROOFING.
CONTRACTORS for RAILWAY PLANT and STORES of every description.
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Manufacturers of all descriptions of
IRON AND WOOD FRAME WAGONS
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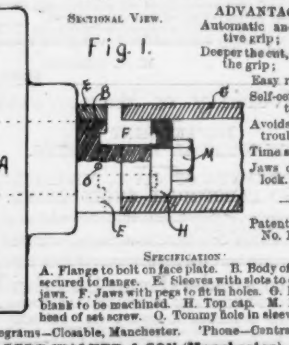
See Illustrated Advt. first issue in each month on page 8.

POLLOCK & MACNAB LIMITED.
"APOLLO" TURRET LATHES.
Works and Head Office:
Bredbury, nr. STOCKPORT.
N111

A New Internal Grip Turning Chuck
Specially Adaptable for Shells.



ADVANTAGES:
Automatic and positive grip;
Deeper the cut, tighter the grip;
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Avoids centre trouble;
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Jaws do not lock.
Patent No. 105,700.

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CAST SOLID TO ANY SPECIFICATION.
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DAVIE & HORNE, Engineers,
Johnstone Engine Works,
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MAKERS OF
Condensing Plants, Distilling Plants, Evaporators, Feed Water Heaters and Filters, Pumps
City Office - - 45, HOPE STREET, GLASGOW.
Telegraphic Address: Evaporator, Johnstone
See Illustrated advt. in issue Aug. 3rd. no123

SYNTHETIC NITROGEN COMPOUNDS.

A GREAT GERMAN WAR INDUSTRY.

The fact that Germany, with practically all her imports cut off, should be able to maintain and augment her resources of the essential ingredients employed in the manufacture of explosives, has always proved something of a mystery to the uninitiated. It is, for instance, a matter of common knowledge that, so far as the manufacture of nitric acid in this country is concerned, we are wholly dependent upon the import of Chilean saltpetre, or nitrate of soda. At the present time sulphuric and nitric acids may almost be looked upon as the very life blood of any warring nation, and that the Central Empires should have solved the problem of the synthetic production of nitrogen compounds to such a degree as to render themselves entirely independent of the imported raw material must redound to the credit of their technical ability and perseverance.

As an illustration of what Germany is doing in this direction, it may be mentioned that her pre-war consumption of nitrogen was in the neighbourhood of 200,000 tons per annum ; but, neglecting the fact that she must have erected for war purposes a number of special plants of which we have no official knowledge, there is more or less definite information that, during the current year, she will be in a position to turn out these products to double the extent of her consumption prior to the war. Some three years ago the quantity of Chilean nitrate imported annually by Germany amounted to about 750,000 tons, and this was sufficient to provide for rather more than half of her requirements. Another source was the lime nitrogen, of which she obtained about 40,000 tons annually from Norway, while her gasworks and coke oven establishments made up the remainder. At this time the synthetic processes were, more or less, in a state of experiment, and had no very material effect on the total supplies. To-day, the more prominent methods available for the recovery of nitrogen in useful form in Germany may be distinguished under the following headings :—

(*a*) The recovery of the element from the distillation of coal either in gasworks, coke oven establishments, or by the use of the Mond and similar producers. In such cases the nitrogen is obtained in the form of the well-known gasworks residual, ammonia, and, if desired, to a very much smaller extent, as certain forms of cyanogen.

(*b*) The synthetic production of ammonia. It is of this process that the future possibilities are enormous, and there is little doubt that it is destined to play a leading *rôle* in chemical industry, not only in Germany but the world over. Ammonia is produced by bringing about the union of hydrogen and nitrogen in the presence of a special catalytic agent.

(*c*) The fixation of atmospheric nitrogen with the aid of cyanamide, or lime nitrogen, as it is frequently called. This process is, of course, dependent for its success, from a commercial standpoint, upon a cheap supply of the well-known compound calcium carbide.

(*d*) The fixation of atmospheric nitrogen with the aid of coal gas, or, more strictly, the gas produced in coke ovens. This is another German process, but although there is definite information of an experimental plant which operated with success at Nuremberg, it is not possible to say, under prevailing conditions, whether the process has been developed on any considerable commercial scale.

NITROGEN FROM COAL.

The nitrogen recovered from coal or lower grade fuels, either by carbonisation or complete gasification, into a producer gas, is almost wholly in the form of ammonia. Ammonia, as a source of nitrogen, is a particularly useful product to Germany, in that it may be directly converted into sulphate of ammonia for use in agriculture, thus taking the place of the interrupted supplies of Chilean nitrate ; or, in the form of ammoniacal liquor, it may be purified and concentrated up into liquor ammoniae, a valuable compound in the manufacture of explosives. But, more important still, it may, with the aid of another process brought to practical perfection by the German chemist, be directly oxidised to nitric acid. There is a good deal of evidence to show that Germany must have realised some years ago that, if future events turned out as was to be expected, the nitrogen products which she was in a position to derive from the carbonisation of her coal would be inadequate to meet her requirements. Accordingly she instituted, through the agency of the famous Badische-Anilin concern, an exhaustive inquiry into the practicability of producing ammonia synthetically, by bringing about the union of the two elements hydrogen and nitrogen. The success of such a process was largely dependent upon the economical production of the two staple gases. The manufacture or separation of nitrogen from the atmosphere was made possible by an adaptation of the well-known Linde oxygen plant, while the production of hydrogen, having a purity of over 99 per cent., presents a fairly simple problem, the iron-water-gas process, as now extensively utilised in this country, being chiefly employed. (For a description of this and other hydrogen processes see The Engineer, January 6th, 1917.)

In spite of the fact that ammonia (NH_3) is a compound consisting of two of the most common elemental substances, its manufacture from these elements presents great difficulties in practice. The outstanding obstacle is the extremely small chemical affinity which the two elements possess for one another, even at a considerable temperature ; but union may be effected provided temperature can be introduced in conjunction with immense pressure. Herein lies the practical stumbling-block, for the containers must be so constructed as to be capable of resisting intense bursting stresses, while they are operated at a temperature approaching 700 deg. Cent. Professor Haber, however, after exhaustive trials has managed to override this problem, and there is little doubt—although it is difficult to persuade the average technical man to this effect—that his process, now perfected, is one which will have a revolutionary effect on the chemical and auxiliary industries in the course of the next few years.

SYNTHETIC AMMONIA.

There is no question, particularly in view of the Ostwald oxidising process discussed later, that ammonia is the most highly desirable form in which to obtain combined nitrogen, in that it lends itself to conversion into a host of essential products. In the Haber process hydrogen and nitrogen, obtained as previously described, are admixed approximately in the proportion of three parts of the former to two parts of the latter. The mixture is then submitted to compression, amounting to some 2600 lb. per square inch, at a temperature varying from 500 deg. to 700 deg. Cent. Following this treatment a volume of liquid ammonia, equivalent to about 10 per cent. of the volume of the original gas treated, is obtained. An interesting feature of the process is the fact that no subsidiary apparatus for supplying the necessary heat is required, for the reaction is highly exothermic, and is, accordingly, in itself its own heat producer. In order to effect the combination of the two elements, and to increase the velocity of the reaction, compression takes place in the presence of a special catalysing material. Haber, if he could obtain it, would employ osmium as his catalyst, but as the entire world's stock of this rare element only amounts to a comparatively few pounds, other substances have had, perforce, to be utilised. Uranium, usually admixed with a liberal proportion of iron or manganese, is generally made use of ; and even iron itself will answer the purpose, provided a high degree of efficiency is not looked for. The gaseous ammonia, after passing through the compression chamber is led into a condenser of ordinary construction in which the ammonia is deposited in liquid form and forthwith collected. In some cases, however, a concentrated solution is obtained by admitting water, in the requisite quantities, to the cooling apparatus. The risk from explosion during the process is somewhat considerable, as may be judged from the fact that the chief plant in operation prior to the war at Oppau, was set up within bomb-proof shelters, and was fitted with elaborate tell-tales designed to indicate the approach of danger. Disastrous consequences would inevitably follow the introduction of oxygen or air into the compression chamber, for the merest trace of either would be sufficient to cause violent explosion. It is for this reason that the plants are fitted with special oxygen-indicating alarms. The well-known difficulty of "poisoning" presents itself in this plant as in all processes in which catalysing materials are employed. For this reason the most careful preparation of the gases is necessary. Sulphur in its various forms is likely to be the chief offender in this direction, and a minute trace of sulphur compounds would be sufficient in a comparatively short time to render the catalyst completely useless. In addition, Professor Crossley states that other active poisons are selenium, tellurium, phosphorus, arsenic, and boron, or the hydrides of these elements ; also many organic compounds and certain metals having low melting points, such as lead, bismuth and tin. These last-named, in the presence of hydrogen, would easily be formed by reduction from their compounds. It is seen then that, in addition to ensuring a gas free from poisons, it is essential to prepare a catalysing medium which itself contains no substances by which the same effect might be occasioned.

THE OSTWALD PROCESS.

Since the production of synthetic ammonia has been placed on a sound footing, both from a practical and commercial standpoint, the most noteworthy development in the direction of producing nitrogen compounds is the Ostwald oxidising process, wherewith ammonia may be transformed into nitric acid. Thus we have an example of one essential form of combined nitrogen being converted into another form, which, in the light of prevailing conditions, is the more valuable of the two. Theoretically, the Ostwald process is a simple one, for it consists in causing ammonia and air, or a mixture of ammonia with air and oxygen, to combine thus :—

$$NH_3 + 2O_2 = HNO_3 + H_2O.$$

Combination is effected, as in the Haber process, in the presence of a catalyst, but, in this case again, the most scrupulous care is essential in view of the possibilities of "poisoning," the catalyst in the Ostwald process being highly susceptible to the effect. This contingency necessitates the use of only the purer forms of ammonia, hence sources of ammonia, such as gasworks and coke ovens, are not altogether suitable, owing to the increased expenditure on purification. As a fact, however, it has recently been shown in America that the use of coke oven ammonia is practicable, providing purification is thorough. Albeit, there is little question that the Germans have discovered that synthetic ammonia lends itself admirably to the process, although cyanamide undoubtedly provides a suitable substance. The Ostwald process has had its critics, particularly in view of the fact that the efficiency of conversion realised is comparatively low, amounting, under best conditions, to no more than 85 per cent. An American authority has said that—the exigencies of war apart—the new method is scarcely capable of competing with the ordinary nitrate process for the manufacture of nitric acid, or with that of the electric arc. As an illustration of his statement he quotes figures which show that the cost of producing nitric acid with raw materials at their present value would be approximately 2.73d. per lb. by the nitrate process, and 2.75d. per lb. by Ostwald's method, the low conversion efficiency of the latter process largely accounting for its high cost of operation. When all is said against it, however, Ostwald's system possesses indisputable merits owing to the continuous nature of production, the little plant required, and the relatively small amount of power necessary, while the exit gases are several times more concentrated than those from any arc furnace.

It is pleasing to be able to record that, although up to a recent date, some half dozen European countries had installed apparatus for the manufacture of nitrogen compounds by modern methods, and whereas Great Britain did not at the time figure in the list, there is to-day a plant at work in this country for producing nitric acid and nitrate of ammonia on the new lines. This plant, according to the chairman of the Nitrogen Products Company, has recently commenced working, although it will be some little time before the factory attains its full output. The greater portion of the plant is entirely new in design. It should be recognised that a British concern has secured the rights of the Ostwald process, which is thus, if taken advantage of, as it should be, available for the use of Great Britain and her Allies at a time when nitric acid is a predominant factor in the maintenance of the explosive supply.

NITROGEN FROM CYANAMIDE.

The supply of calcium cyanamide is dependent upon calcium carbide, a compound which was, until recent years, manufactured in comparatively small quantities. Where, however, sufficient power is available—and abundant water power is generally regarded as the *sine quâ non*—it is an easy matter to produce the carbide in an electric furnace capable of attaining a temperature of about 3500 deg. Cent. The process is based upon the fact that if lime is admixed with carbon and heated in a crucible, the resultant products will be calcium carbide and carbon monoxide. On the practical scale lime or chalk is utilised, while the carbon is supplied in the form of anthracite, and although Norway, and particularly the region round Odda, is the home of the carbide industry, the anthracite was, in pre-war days, usually shipped from this country. In fact, owing to the lack of coal-washing facilities over here, the coal was in some instances discharged *en route* at Hamburg to undergo this treatment. As turned out from the electric furnace the raw cyanamide possesses the chemical formula $Ca\ CN_2$, and contains about 25 per cent. of nitrogen. In order to convert this product into ammonia it is treated with soda ash and slaked lime, the mixture is then subjected to a temperature of about 160 deg. Cent. in the presence of superheated steam, when ammonia is produced as follows :—

$$Ca\ CN_2 + 3H_2O = Ca\ CO_3 + 2NH_3$$

The quantity of lime and soda ash added is comparatively small, amounting in all to only about 5 per cent. of the weight of the cyanamide. The reaction itself is highly exothermic, with the result that, once started, it is capable of generating sufficient heat for its own operation. One of the engineers of the American Cyanamide Company has stated that a factory erected in Canada has a capacity for fixing nitrogen equivalent to 90,000 lb. of ammonia per day. A plant destined for erection in America was interfered with by the outbreak of war, and the apparatus, which was to have been delivered by Germany, was commandeered for the purpose of adding to its own units. It is interesting to hear the testimony of the American company to the fact that the ammonia yielded by the cyanamide process is so pure that it may be employed in the Ostwald process without any fear as regards the poisoning of the catalyst. Cyanamide ammonia lends itself to concentration into the anhydrous product, and has been used for this purpose in France to some considerable extent.

NITROGEN FROM COAL GAS.

Mention has already been made of the method originating in Germany for fixing nitrogen with the aid of coal gas or coke oven gas. Discovery of this method is due to Professor Häusser, who conducted his research on the lines of the well-known fact that when a combustible product such as coal gas or producer gas is exploded traces of nitric oxide gas (NO) are found. As a result of explosion nitrogen and oxygen combine according to the following equation :—

$$2N_2 + 2O_2 = 4NO.$$

The nitric oxide possesses, however, a tendency to-

AN EARLY AMERICAN CHAIN-TRACK TRACTOR

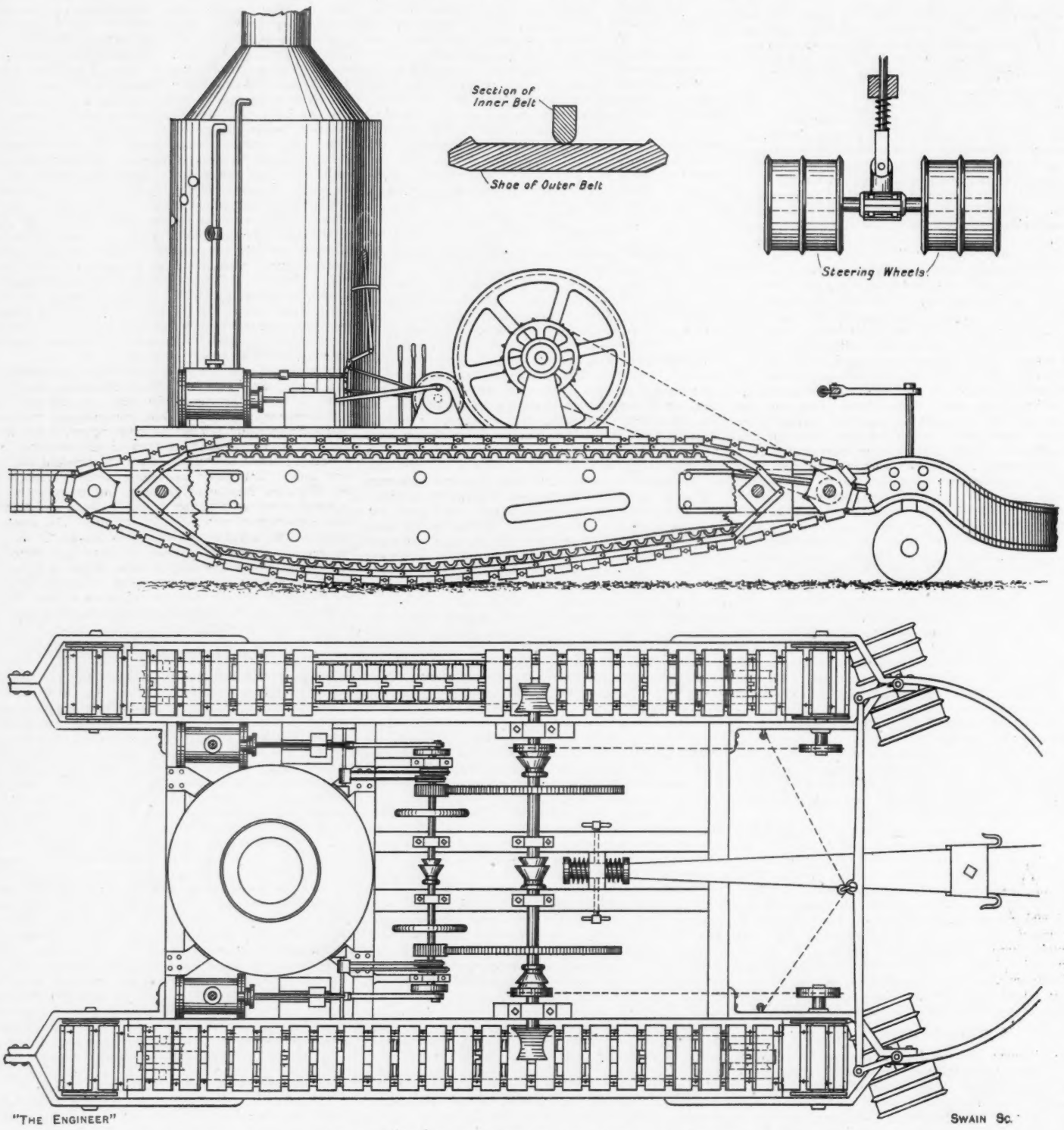


Fig. 14—ELEVATION AND PLAN OF THE BATTER TRACTOR, 1888

wards oxidation into nitric oxide (NO_2), but it has been shown that if extremely rapid cooling is arranged for this oxidation may be checked. The process is carried out in steel explosion chambers of immense strength, connected, in the original plant, to a compressor which delivered the mixture of gas and air to the chamber at the desired pressure, ignition taking place by means of a magneto within the chamber. After explosion has occurred an exhaust valve is released, and the products are scavenged out of the cylinder by a current of compressed air. The method of obtaining a considerable temperature drop is ingenious, and brings in the principle of sudden expansion through an orifice. For instance, immediately following the explosion the exhaust valve opens and permits the products to expand suddenly in the collecting vessel. Professor Häusser originally adopted the idea of spraying a jet of water into the chamber, but this method possesses a drawback in that it gives rise to the formation of nitrous acid (HNO_2), which is found to destroy the valves. In the latest type of plant, so far as is known, gas and air are compressed not in the same but in distinct compressors, and in order to increase the temperature of explosion, and therefore the efficiency of conversion, the air is pre-heated before passing to the chamber. This pre-heating is effected by means of a suitable gas furnace. On leaving the explosion chamber the products are condensed by passage through a coil submerged in water, when the water produced by combustion is thrown down. The remaining products are then led through a cast iron oxidising tower, and from that they travel through scrubbers, in which the nitric acid is washed out. The acid is produced according to the following reaction :—

$$4\,NO_2 + O_2 + 2\,H_2O = 4\,HNO_3$$

In this way a product of some 40 per cent. strength is yielded, and this may be concentrated by evaporation and re-distillation. As regards the Nuremberg plant it is gathered that the yield of nitric acid amounts to about 7 lb. per 1000 cubic feet of gas treated, but it is obvious that if gas is to be used in bulk for this purpose the economies of the process will not present a particularly alluring prospect if the value of nitrogen products, owing to the increased output which may be expected from the growing use of synthetic methods, is likely to fall much below the normal figure. The process, however, has distinct advantages when considered in conjunction with those coke ovens where some difficulty may be found in disposing of the surplus gas.

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. III.*

In the patent, 1804 of 1882, taken out by H. G. and W. Woodbridge, we get quite a new departure. The general principle involved is shown diagrammatically in Fig. 15. There is the chain of links which in so many forms had been suggested by previous inventors, and it enveloped only one set of wheels of the vehicle, but there was this great difference from those which had gone before it, that though it formed an endless track on which the wheel travelled, it also transmitted the power from the engine, and by its very motion caused the vehicle to travel. The inventor proposed not only to apply the idea to traction engines, but also to portable engines, so that they might be made self-propelling. It is difficult to see exactly what real good it was hoped to achieve by this device, and it would appear that a considerable amount of energy would be wasted.

In the patent of Jonathan Aldous Mays—No. 5079 of 1884—there is again the idea of enveloping the wheel with a series of plates which were to serve as rails. The specification is interesting in that the

* No. II. appeared August 17th.

patentee seeks to trace the analogy between his proposals and an ordinary railway. He says:—"My revolving railway may be said to consist of sleepers, chairs, and rails, but instead of being permanently fixed to each other, as in the case of a permanent way, these several parts are jointed together to form an endless chain around the periphery of the wheel. The sleeper consists of a broad rectangular or other suitably shaped plate, upon the upper surface of which are placed vertical supports or standards for affording an axial support to the chair. The "chair" consists of a piece of metal supported by, and having an axis of rotation upon the sleeper in the line of motion of the wheel, and it supports the rail in such a way as to permit of its having an axis of rotation upon itself at right angles to its own axis of rotation upon the sleeper, and preferably in the same plane. The "rail" consists of a length of metal or other suitable material of any convenient section, and having at each end lugs or projections by which it is fastened to the chair. On a series of rails, chairs, and sleepers being connected together on the axes thus described an endless chain is formed which encircles the periphery of the wheel. By reason of the connections of the rails to the chairs and of the chairs to the sleepers being made at right angles to one another, universal joints are thus formed which permit of the sleepers being laid on the ground in planes at any convenient angle to the horizon. The sleepers consequently adapt themselves to irregularities of the surface of the ground, and yet afford firm support to the rails without unduly straining any of the parts.

In the British patent of G. F. Page, of Baltimore—No. 13,702 of 1884—the chain of links is taken over both driving, and, as the inventor terms them, "pilot or guiding wheels." There are two noteworthy features in the specification. One is that the wheels are grooved, and the other is that the front wheels are made to slew.

Sketches of the arrangement are shown in Fig. 17. The method of slewing the front wheels will be observed. The inventor states, in his specification, that because the centre line of the groove of the wheel passes through the point round which the wheel is slewed, the chain will never be tightened by the slewing, and will only be slightly slackened. Apparently the rear wheels were not to have any slewing motion. The shape of the links is claimed to be such that neither stones nor dirt can get in between them and interfere with the working. The rear wheels are intended to be the driving wheels, but the inventor does not state how he proposed to transmit the motion of the engine to them.

Henry Gartside Tipping, in his patent 16,699 of 1886, simply suggests the use of a series of seven hinged or flanged plates to be applied to the wheel. He was a lieutenant in the Royal Navy, and was probably unaware that practically the same thing had been patented over and over again. However, he thought he had got a really good thing for enabling lifeboat cradles, artillery carriages, &c., to be taken over sand or other soft ground without sinking in, and he patented his ideas.

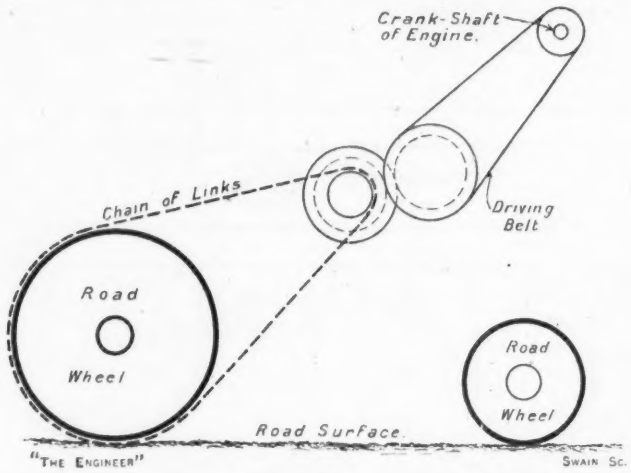


Fig. 15—SKETCH SHOWING ARRANGEMENT OF WOODBRIDGE TRACTOR, 1831

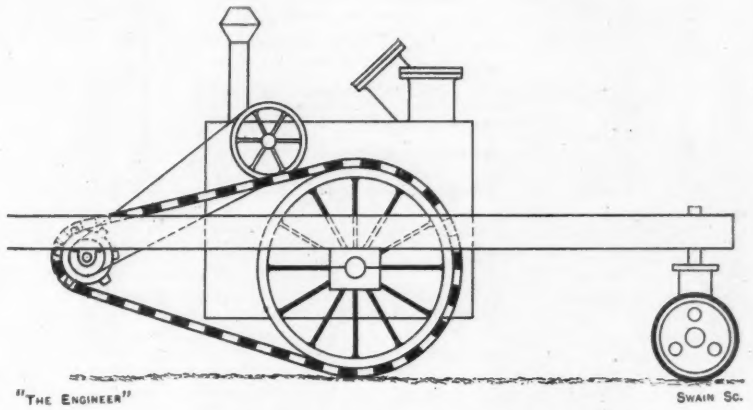


Fig. 16—SKETCH SHOWING ARRANGEMENT OF APPLEGARTH TRACTOR, 1886

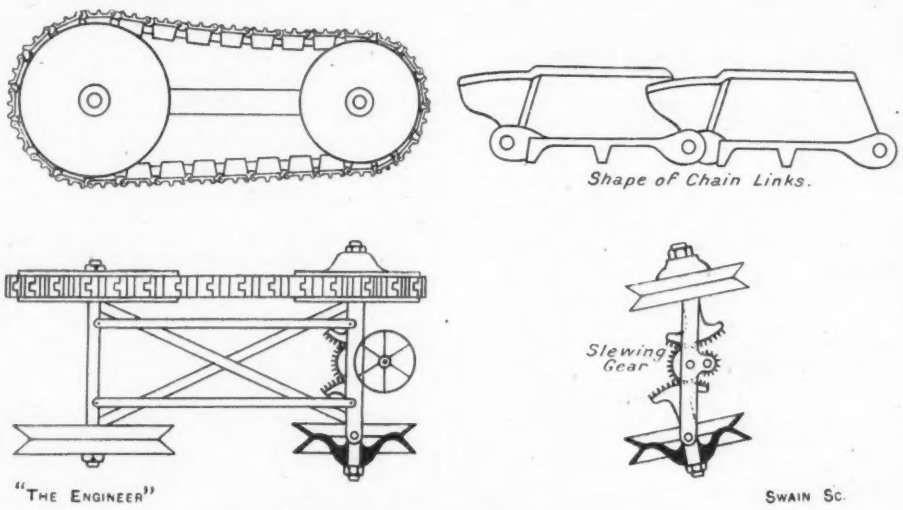


Fig. 17—ARRANGEMENT OF THE PAGE VEHICLE, 1884

Taking matters in the correct order of dates, we now come to three United States patents, namely, those of (*a*) W. Applegarth, No. 352,385 of 1886; (*b*) F. W. Batter, No. 382,857 of 1888; and (*c*) G. H. Edwards, No. 425,600 of 1890.

The arrangement proposed by Applegarth—see Fig. 16—had a distinct resemblance to that of the Woodbridges—Fig. 15—already referred to, but there was a certain amount of difference, as will be seen by comparing the two drawings, both of which are diagrammatic only. There would not appear to be any reason why Applegarth should have idea of the inventor admirably, so that but little description is necessary. It will be seen that there are two sets of endless belts, one set being arranged on each side of the vehicle. The outer belt—that which impinges on the ground—is composed of shoes arranged transversely and coupled together. These belts pass over hexagonal pulleys, two at each end of the vehicle, the forward of which is driven from the countershaft of the engine. In contact with these outer belts, and coming between them and a series of rollers arranged along the top and bottom of the frame of the machine, are two other endless belts—one on each side of the machine—these revolving on square pulleys, and being of much less width than the shoes of the outer belt, which are formed of blocks of wood, and which have a considerable length transversely in order to provide a sufficient bearing for the machine on soft or yielding ground. The two chains of shoes are independent of one another, being driven separately. The inventor does not claim any particular method of connecting the shoes together, simply saying that the form of link or joint must be such as will allow the belt to turn freely about the polygonal pulleys or rollers. The links of the inner chains were to be united by pins, so that the links might rest on the middle portion of the blocks or shoes of the outer chains. The anti-friction rollers on the underside of the frame are arranged close together and are alternately flanged and plain, this method being chosen because, while the alternate rollers with flanges keep the whole row in place upon the links of the chain, the fact that the alternate rollers are without flanges permits of a greater number being got into the same length than would be possible if all were flanged. The inventor's idea was that since the shoes of the outer chains were of considerable length, while the links of the inner chains were comparatively narrow, the former might adjust themselves to irregularities of the ground, but the working of the rollers would not be interfered with. The arrangements of the steering wheel is to be noted, there being two sets of double wheels so connected that the two sets slewed together. It will be observed that the employment of these wheels, besides rendering steering possible, results in the lifting of the end of the chain off the ground, so that both ends are held clear of it.

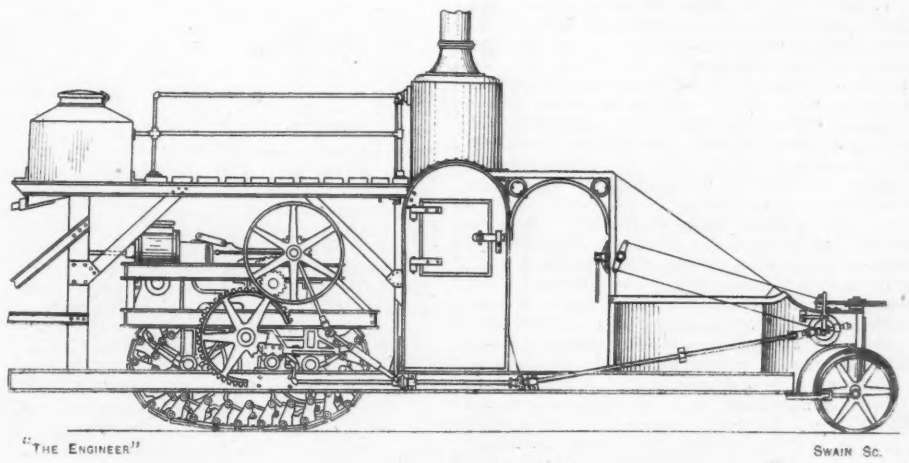
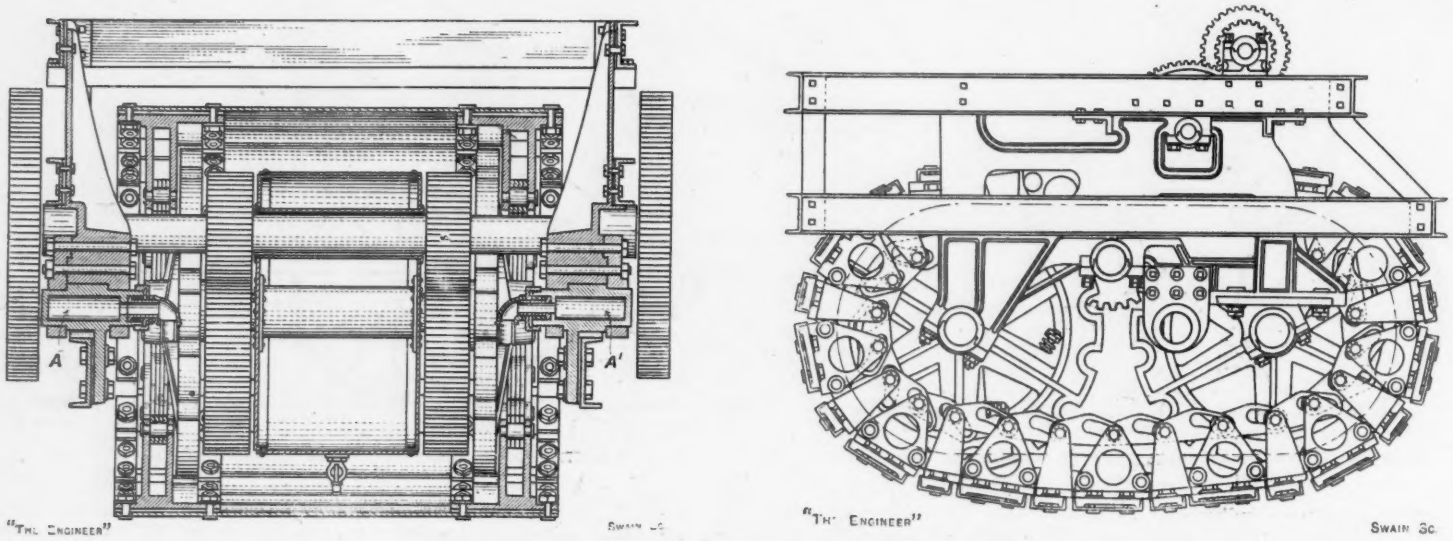


Fig. 18—THE EDWARDS TRACTOR, 1890

The general arrangement of the Edwards tractor is shown in Fig. 18, while in Figs. 19 and 20 are given a cross section and a side view of what the inventor terms a rocking truck, Fig. 20 showing a slightly different form of truck to those depicted in Figs. 18 and 19. A feature of the invention is that the frame carrying the engine is free to move independently of the lower frame on which the boiler is mounted, the two frames being connected by trunnions, which are shown at A A^1, in Fig. 19. Preferably the inventor conveyed steam from the boiler to the engine through these trunnions. There are numerous ways of forming the flexible hinged connections between the braces which carry the slats forming the endless track, but possibly the most interesting of the lot is that illustrated in Fig. 20. As shown in the drawings, there are only two pairs of wheels which carry the weight of the vehicle—with the exception of that part of it which is supported by the steering wheel—and which bears on the endless track, but it is pointed out that one or more pairs of wheels may be arranged to intervene between them if it be desired to lengthen the truck frame. The inventor points out that he prefers to have all the wheels gearing with the endless track, but that though all these wheels may be driven from the engine he prefers only to drive the rearmost wheel. For gearing with lugs formed on the inner side of the endless track the wheels are provided with recesses formed at regular intervals on their peripheries, as is well shown in Fig. 20. The inventor also points out that the track may have two sets of teeth or lugs, the teeth of each set being "in endless series." The endless track is provided along its inner side, with—to quote the words of the specification—"an endless folding truss, which is desirably duplicated so as to provide two parallel lines of trussing, respectively adjacent to the vertical planes in which side wheels are arranged." Various constructions can be employed for this purpose, but it is stipulated that it is essential that the folding truss should be of such a character that it will fold to permit the endless track to pass about the wheels and unfold to permit the track to straighten out between the forward and rear wheels. It is further explained that it must unfold only to such extent as will allow the track portions which may be between the front and rear wheels to straighten out, so that the lower leaf of the endless track will be braced and held rigid against upward pressure, and lie upon the ground as a flat broad bearing. In this way the weight of the truck frame and engine will be sustained in such a manner that the "weight will be distributed throughout the leaf or lower fold of an endless track, whereon the wheels are arranged to roll."



Figs. 19 and 20—CROSS SECTION AND SIDE VIEW OF EDWARDS' TRACTOR, 1890

In explanation of the method employed of connecting the two parts of the structure by means of trunnions, as referred to above, so that the engine truck can rock independently of the main frame, it is pointed out that this independent rocking action permits the slatted track to conform to irregularities of the ground. In passing over a ridge or similar obstruction the lower leaf of the track, which is rigid as against upward pressure, will be permitted to lie flat upon the inclination of the ground. If, says the inventor, the engine truck were rigid with the main frame, the full leverage of the driving wheels could not be utilised, and undue weight would be thrown upon the steering wheels. He maintains that by thus providing a rocking connection between the engine truck and the main frame his type of track will adapt itself to irregularities of the ground without materially altering the portion of the weight normally carried by the steering wheel, and the full leverage and power of the engine-truck wheels may be utilised.

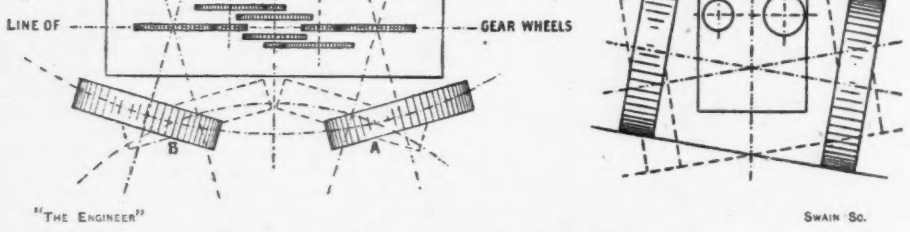


Fig. 21—THE ORIGINAL DIPLOCK TRACTION ENGINE, 1893

We must here refer to the early work of Mr. Bramah Joseph Diplock. To give the whole history of his investigations would require more space than we can afford, and we must therefore content ourselves with a brief discussion of some of them.

The fact that there was room for a great deal of nothing to do with the particular subject we are discussing, namely, the evolution of the chain-track tractor, but, since it served as a stepping stone to further developments it should just be mentioned. In the year 1893 he took out a patent for a traction engine, the wheels of which were (*a*) all driven from the engine; (*b*) all of the same size; (*c*) all used for steering; and (*d*) the axles of which could accommodate themselves horizontally to irregularities of the surface being traversed. We give in Fig. 21 some sketches which will serve to explain in broad outline the principles involved. This engine was tested by Colonel Crompton who, in 1899, reported concerning it that the tests following on others which had been made by Mr. Richard Muirhead "justify me in saying that I believe that the hauling power of Mr. Diplock's engine is fully fifty per cent. in excess of that of the ordinary form of hauling engines of the same weight, and there is every possibility that the percentage of increase of hauling power may even be greater than this when the weight is more equally disposed over all four wheels than is the case in the experimental engine."

With this engine, too, Mr. Diplock satisfied himself that on roadways area of surface contact counted for more than weight in obtaining adhesion. This led him on to design his first "Pedrail" tractor, which we shall describe in its proper chronological order, and, eventually, as we shall show, to his chain-track tractors and vehicles. Meanwhile, we pass on to the consideration of other inventions.

The next patent in order of date is that of William Gwinnett, a steel ball manufacturer, of Wolverhampton, and the object of his invention was to reduce the friction in the endless track. The proposal is illustrated in Fig. 22, which is reproduced from specification No. 10,404 of 1895, and requires very little description. First of all there was what the inventor describes as the runner A, which had top and bottom longitudinal members joined together by curved ends. This "runner," therefore, had a continuous outer face, in which was formed a groove to provide a chase

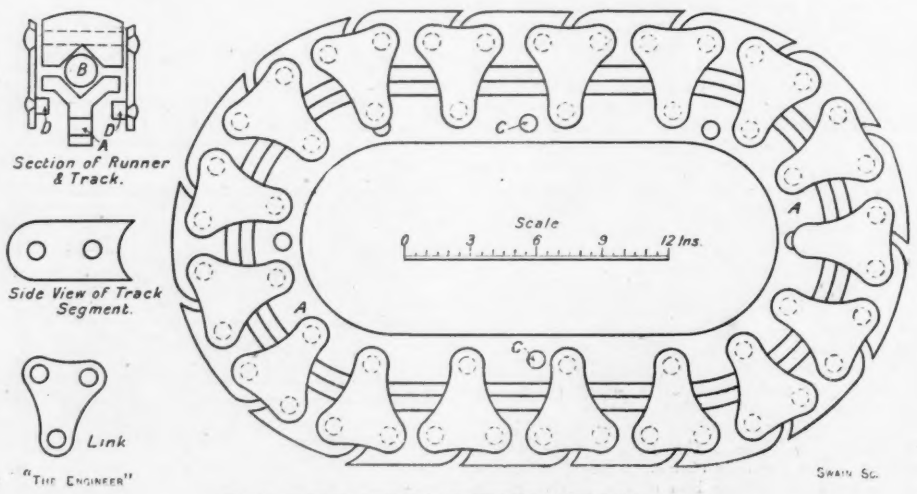


Fig. 22—SKETCH SHOWING GWINNETT'S PROPOSAL, 1895

for a number of steel balls. There was a series of segments, connected together by links, and provided with grooves to fit over the line of balls B and to revolve on it. This series of segments, of course, formed the track on which the vehicle progressed when the motion was imparted to the segments, and for ordinary vehicles there was one series of segments or more on each side, and the segments, when used on soft ground, were to be formed with specially broad bearing faces. Pads or treads of rubber or other soft material might be fixed on the bearing faces of the segments, so as to reduce vibration and noise, or a pneumatic tire might be placed round the track for the same purpose. It will be observed that the vehicle had no real wheels. The body of the vehicle was to be attached to the runner by means of the holes C, and the whole contrivance was to take the place of wheels. If the vehicle was to be self-propelled the motive power was to be applied to the upper portion of the track, and one method of doing this might consist in driving the track through the medium of a spur wheel gearing into a rack or chain carried by the track. The series of segments would be prevented from coming off the runner by reason of the ball chases, but as a further protection the links were provided with cheese-head rivets, D, which embraced a continuous rim on each side of the runner.

TRANSMISSION OF CONCRETE BY AIR AND STEAM.

(By a United States Contributor.)

THERE are several methods of getting concrete from the mixer to the point of use, not the least of which is the one which makes use of the gravity chute. In the United States this system of transmission has been very highly developed. But the engineering world is not easy in its mind over this method. A certain degree of steepness of the chute is a necessity in order to make gravitation do its work, and this steepness seems to promote the separation of the concrete mixture into its physical constituents. The concrete may be well and thoroughly mixed when it leaves the mixer, but every foot of slide tends to undo the mingling of the ingredients.

We are not to be surprised then that the gravity chute is scarcely considered the last word, and that there is an opening for something better. Moreover, the problem of transmission is such a wide one that we can hardly expect a single system to afford a full and complete answer. Even if the gravity chute, for example, did not promote disintegration of the mixture, it would not be generally applicable to the placing of concrete in the arches of tunnels. Really what is needed is an economical system which shall put at the back of the concrete a compelling impulse of such a nature that it will operate upgrade, as well as downgrade, and will carry the mixture around curves as well as along right lines. There are two American systems which are coming into notice, both of which may lay claim to satisfy to a greater or less extent these requirements. One makes use of compressed air; the other, of live steam. The former has probably had a wider application and has in consequence reached a higher degree of development. Nevertheless, the technique of the method does not seem to be fully known to all users, so that there is variation in the results. Enough has, however, been demonstrated to make it clear that the pneumatic method is a thoroughly practical thing, and very advantageous under certain conditions. We are not to confuse this system with any of the methods where concrete is sprayed on to a surface. Compressed air is now being used to handle quickly concrete in considerable masses—to deliver it where large quantities are to be rapidly placed. The system of transmitting concrete by steam, while less developed than its rival, is, nevertheless, advancing steadily.

Other things being equal, the steam method would often be preferable to that using compressed air, because of the comparative ease with which steam may be generated. No special generating equipment is needed. The ordinary steam boiler is sufficient. Steam is needed in quantity at 80 lb. or 100 lb. pressure, that is all. It must be said that this feature is quite a valuable one. There must be many jobs where it would be expensive or inconvenient to install an air compressor, but where steam could be very readily provided. On the other hand, the effective radius of transmission may very well turn out to be greater with compressed air. The use of steam is limited to the distance over which the steam may be transmitted in a thoroughly live condition. Still, even so, it must be remembered that we are living in the days when 85 per cent. magnesia and similar heat-insulating materials are available, the methods of applying which are pretty well known. Apparently, the compressed air method is at present limited to a radius of 1000ft. or even less. We are not at all entitled to say that it will be unduly costly or highly inconvenient to transmit live steam an equal distance. It is very possible that eventually, even for long distances, the cost and inconvenience of supplying compressed air will fully offset the expense and difficulty of eliminating and overcoming the heat losses in transmitting steam. But whether the steam system will ever be able to compete on equal terms with the compressed air method when it is a question of conveying large quantities of concrete is another matter.

That the general procedure is, however, becoming thoroughly practical for the placing of concrete in considerable amounts has quite recently been illustrated by its employment in connection with the new subway construction at New York. However, instead of steam, heated air was employed to furnish the driving force. This substitution was probably made to avoid the introduction of exhaust steam into the tunnel. The tubes being constructed under that arm of the sea known as East River to connect Manhattan with Brooklyn are being lined with cast iron segments bolted together by means of flanges. The joints lie in transverse vertical planes, and in planes passing through the tunnel axis. In one of these tunnels the flange depth on the shorter face is 9in. The bulk of the concrete lining is being placed by rather ordinary methods. However, for a stretch in the crown of the arch the new procedure has been employed. The width of arch involved is about 7ft., or something less than 60 deg. of the arch on a 7½ft. radius. It was required to fill the 9in. of depth involved in the numerous pockets included between flanges and to add 6in. more. No reinforcement was to be used. This work has been successfully and rapidly done. A metal nozzle, radially directed, was mounted in such way as to be capable of being shifted by power in a transverse arc. Longitudinal motion was obtained by moving the car carrying the apparatus. The concrete mixture employed was a rather unusual one, the formula followed being 1 : 5 : 2. The coarse aggregate was in the form of rounded pebbles.

The new subways are being constructed under the supervision of the Public Service Commission. The new method had to satisfy its engineers before permission was given to use it. In one series of tests carried out by the Commission, various mixtures of concrete were projected by steam jets into wooden forms of such size as to produce cubes 15in. on a side. Blocks 6in. by 6in. by 12in. in size were cut from these, and tested after reaching an age of 28 days. The 1 : 2 : 1 hot air concrete weighed 136 lb. per cubic foot, and yielded in the crushing test at 76,720 lb., or 2131 lb. per square inch. The 1 : 3.3 : 1.1 concrete weighed 135 lb. per cubic foot and gave way at 87,120 lb. pressure or at 2420 lb. per square inch. Finally, the 1 : 6 : 2 concrete weighed 136.2 lb. per cubic foot, and succumbed to the crushing test at 58,800 lb., or 1633 lb. per square inch. The tests were made on March 20th, 1917. That the first two blocks were very strong, is indicated by the fact that, of all the 28-day tests conducted by the laboratory for the year ending March 31st, 1916, the average crushing test was only 1725 lb. per square inch. Prior to the tests of concrete forced by jet into wooden forms, several tests were carried out on blocks (6in. by 6in. by 12in.) cut from cubes (15in. by 15in. by 15in.) cut from various portions of an arch concreted by hot air. These tests were made at the age of 31 days. The average weight was about 159 lb. per cubic foot, and the average crushing strength 3157 lb. per square inch. In consequence of its investigation, the Public Service Commission gave its consent, permitting contractors to use the 1 : 5 : 2 concrete applied by the new procedure by the aid of hot air over any part of all of the crown of 26 miles of tunnel arch.

The apparatus used in connection with the steam method consists of two parts:—(1) The mixer, and (2) the "atomiser" and transmitter. In the one part of the machine the raw materials, including the water, are first thoroughly commingled. The proportioning is done before or at the moment of delivery of the materials to the mixer. Steam is then admitted, a double purpose being in view. First of all, it is very necessary that the concrete to be transmitted shall be pretty well heated. Otherwise, there may be excessive absorption of heat from the driving steam at some point out on the transmission line. It is also essential that the heat content of the steam shall be conserved all along the transmission pipe. Indeed, it is not permissible that the superheat should be quite exhausted when the nozzle on the discharge pipe is finally reached. A cloud of vapour is not wanted between nozzle and point of application of the concrete stream. A second reason for the admission of steam into the mixing compartment is that it is desired to begin, even at that stage, the development of a pressure on the concrete. The mixing is done mechanically by means of rotating paddles or the like. After the mixing is nearly completed, steam is admitted to the "atomising" chamber. The two compartments are connected, a valve serving to open and close communication. When steam is first admitted to the second chamber the valve is closed. The effect is to warm up the chamber and create a flow of steam through the transmission pipe-line into which the "atomising" chamber discharges. The steam pressure used will be no higher, perhaps, than 30 lb. The transmission line will soon be cleared out and pretty well preheated. The valve between the two compartments may then be opened. As the steam pressure used in the mixing compartment will be at 80 lb. or even more, there will be a differential pressure in the direction of the second chamber. Because of this pressure and the "worm-action" of the rotating device, the mixed concrete will flow into the "atomising" compartment. Now just what happens there is not quite clear. It is possible that no one has precise knowledge. At any rate, the concrete passes out into the pipe-line, a fairly high pressure of steam constituting the impelling means. It is understood that, as the concrete passes out into the transmission line, it drops into a current of rapidly moving superheated steam. The steam pressure carries the concrete along and finally discharges it through the discharge hose and nozzle or other terminal device.

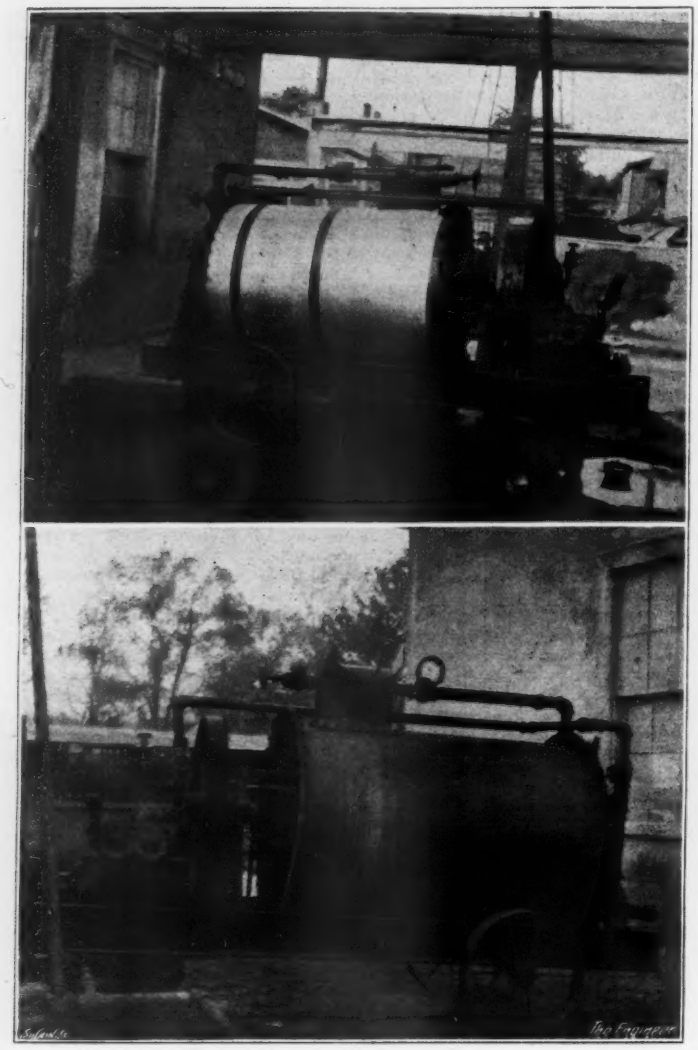
The transmission may be effected through wire-wound rubber hose of a diameter as small as 1¾in. Naturally, a small tube will have the effect of limiting the amount conveyed. But we are by no means tied to small hose; steel pipe of considerable diameter may be employed.

The problem of using good-sized steel pipe is a complex one. First, the pipe must be thoroughly protected by a high-class heat insulating material. Then, the pipe-line must be portable. This really means that the line must consist of short lengths easily connected up and easily separated. Further, the connections should permit of some degree of flexibility. It is easy enough to provide for curves and bends involving considerable angles of deviation, but it is desirable that tangents also be not too rigid in their straightness. To meet this requirement, about the only simple and practical thing is so to design the connections as to have the joints more or less flexible. This must be done in such a way as to conserve heat. The foregoing are being dealt with by the inventor along the following lines. A coated steel pipe is employed for transmission, the normal lengths being, say, 23ft. each. A heavy envelope of magnesia is placed round the pipe, and the whole is enclosed in a spiral sheet-metal tube. This last may be regarded as used principally for the protection of the magnesia against mechanical injuries. Three chairs are allotted to each 23ft. length—one at either end and one in the middle. These provide means for supporting the pipe when in service, and for moving it when changing position. At the joints a sleeve is provided which covers both pipe ends. A simple device locks the sleeve in place. No wrench is required. The joint is understood to be sufficiently flexible to permit of a 15 deg. deviation from a straight line. It would seem that everything is going to hang on the completeness of the heat insulation at these joints. The conservation of the heat in an ordinary rigid pipe-line is a solved problem. There is no difficulty in providing for an insulation having an efficiency of 85 per cent. or even more. The efficiency realisable with flexible joints is, apparently, a question to which there is no precise and reliable answer available. However, a moderate drop in efficiency there would affect only a very small total section of the line. Possibly, a few additional pounds added to the steam pressure would offset the loss at a small cost. With the heat insulation of the joints carried out with some approach to standard efficiencies, we may expect the whole line to afford a practical means of effecting long transmissions of concrete. The conservation of the heat of the steam appears to be the only problem as to which there is not already at hand sufficient experience to guarantee results. In other words, experience with the pneumatic transmission of concrete shows that air under pressure is competent to drive the concrete through 6in. and 8in. pipe-lines. If condensation can be prevented, there seems to exist no substantial reason why steam should not be an adequate means of securing at least equal results. In the opinion of the writer, then, we are in a fair way to have available for engineering use an economical method of placing concrete in difficult places.

One of the defects of ordinary methods of placing concrete is that they do not themselves perform the tamping operation. The result is that tamping is altogether omitted, is imperfectly done by hand, or else is done at considerable expense for adequate supervision and for labour. Both the pneumatic and the steam processes effect thorough tamping—or may ordinarily be made to do so—as a usual concomitant of the placing operation. The concrete is discharged with force. This may often be utilised so as to do all, or more than all, that can be done by hand tamping. However, experience with the pneumatic method would seem to indicate that conditions are sometimes such that the impact of the concrete upon arrival can not be used as a substitute for tamping. It may be altogether inconvenient or even impossible to discharge the concrete at the ultimate point at which it is to be placed. Actual delivery from the discharge tube may at times be several feet distant from the final destination, requiring that the concrete find it by flowing into position. We are not to expect the impossible or a solution of the placing problem so perfect as to include all minor details.

Further, it has been found difficult, when using compressed air, to fill all overhead pockets in a rock tunnel with such perfection as to eliminate small bodies of trapped air in the bottoms of irregular depressions. This same difficulty would, it is natural to suppose, be associated also with the steam procedure. Such pockets may be concreted by hand methods in advance. In fact, it may seem advisable to plaster over the whole surface in order to give it some approach to regularity. But neither the pockets themselves nor the general surface need be dealt with by anything else than the steam method itself. The difficulty of filling the depressions occurs

PLANT FOR TRANSMITTING CONCRETE THROUGH PIPES



STEAM ATOMISER AND MIXER

STEAM BOILER AND STEAM ATOMISER AND MIXER

when great masses of concrete are being steadily delivered through a pipe of considerable cross-section. The difficulty experienced when using compressed air, the difficulty to which reference has been made above, occurred when filling in the arch on a section of the new subways at New York. The concreting was being done with compressed air by means of a heavy pipe-line laid parallel to the axis of the tunnel. At first this line terminated in a T-connection at a considerable distance back in the section to be concreted at the time. By swinging the T alternately from right to left delivery would be made, now to the right side of the arch, now to the left. The pipe-line would be elevated to about the highest possible level of the rock excavation. Later on, when the rear portion had been concreted, the line would be shortened so as to project but a few inches into the space now to be filled. A high position would be selected. Now, with the steam machine, of which I am giving an account, we are not limited to bulk delivery; so that it is quite possible for us to divide the concreting into two quite distinct operations. And what is more—the preliminary operation may be carried out economically.

The steam procedure has been used in practice where the very object in view was the concreting of an irregular, overhead, tunnel surface. For example, one of the prominent American railways had the duty of providing for the maintenance of two old water conduits passing beneath the bed of a canal no longer in use. These tunnels have a height of about 5ft. They were constructed very many years ago. The masonry lining was in very bad condition, the mortar between the stones having suffered so severely that the lining was largely reduced to stones and cracks. In dealing with this rough and irregular surface, it was not found necessary to set up either the boiler or the mixing and "atomising" machine in the tunnel. Both were left above ground and merely the transmission tube carried down into the interior. The concrete was made with very small pebbles for the coarse aggregate. I am not informed as to the proportions used on this particular job, but think it very possible that the formula was 1 : 3 : 2. It will be noted that while this formula calls for no greater proportion of cement than ordinary practice recognises, yet the relative amounts of fine and coarse aggregate, when compared with each other, are different. The fine aggregate preponderates over the coarse, instead of the reverse, as is usual in ordinary practice. On another tunnel job, this formula, 1 : 3 : 2, was made the rule. Doubtless, the preponderance of the fine aggregate over the coarse is a concession made necessary by the use of a small transmission tube. On this second job it consisted of 1¾in. rubber hose (wire wound), and it is quite possible that precisely the same size and character of tubing was used on both. At any rate, on the job where it is known that the transmission line was a small rubber tube, the relative amount of water used in mixing the concrete was 10 per cent. by weight. To return now to the tunnels beneath the old canal—the concrete was delivered on the irregular surface in a kind of spray. The stone lining was, in fact, bombarded. At the beginning of such an operation the small pebbles, and even the sand, fail to remain fixed but bound off again. This is easily understood. The considerable particles will not stick until there is a suitable layer of cement to hold them. Consequently, we obtain apparently a thin layer of neat cement as a foundation. Sand begins to adhere after a little; and later on the pebbles. On this job there were many instances of pockets, where large stones had dropped out from the lining. These varied in depth up to 6in. or 8in. The concrete was, on this job, carried through the pipe-line for distances running up hundreds of feet. It might be thought that the exhaust steam would create difficulties when the system is used, as it was there in a confined space. In fact, there was some anticipation of trouble on this work, both because of the exhaust steam itself and of the heating effects. If such trouble had developed the difficulty would, perhaps, have been amenable to a forced draught. As a matter of fact, the difficulties feared did not materialise.

To another instance of the use of the steam procedure in tunnel work allusion has already been made. This was a regular railway tunnel belonging to the Chicago and Great Western Railway. This tunnel is half a mile long, and is an old piece of construction. At first, the lining was of timber. Later on—that is to say, about thirty years ago—a brick lining was put in without removing the old. The intervening space was not filled in, and, as a consequence, a good deal of hydrostatic pressure developed behind the brickwork. During the winter the temperature within the tunnel is for a considerable part of the time at or below the freezing point. Because of the freezing of the water at the back of and saturating the bricks, or because of the chemical action due to the mixing of water and locomotive gases, or for both reasons, the brickwork disintegrated very much from one end of the tunnel to the other. The inner ring of brick was entirely destroyed in considerable sections, particularly in the arch. It was impossible to remedy the conditions of simply constructing a third lining of ordinary character within the brickwork, as the effect would have been to reduce the cross-section too much. The material through which the tunnel passes is of rather a treacherous character; so that the expense and danger of effecting a replacement of the lining seem to have exercised a deterrent influence. To meet the situation, the steam procedure of transmitting and placing concrete was resorted to, and the brick lining given a consolidating and smoothing treatment with a 1 : 3 : 2 concrete conveyed through a 1¾in. tube. It might be thought that the procedure would be excessively slow and expensive. As a matter of fact, it is neither. It is said that a typical record on this tunnel was the lining of 262ft. of tunnel for a width of 11ft. in a period of six hours. It is understood that the cement requirements were 35 bags. This means about 3300 lb. of cement, and indicates about 5½ cubic yards of concrete. That is to say, a little less than 1 cubic yard was placed per hour. The total cost of the treatment of the entire tunnel was 4600 dols. The concrete was handled somewhat differently there from what was the case when dealing with the water conduits beneath the canal. A very short transmission line was used. That is to say, the concrete was not mixed outside the tunnel and then transmitted from this exterior point. Instead, two or three cars and a locomotive constituted the basic item of equipment. The mixing and "atomising" apparatus was set on a flat car, and the concrete transmitted to a second flat car, on which was rigged a special nozzle capable of being shifted lengthwise of the car and of being rotated through an arc in any single position occupied by it relatively to the tunnel.

From the foregoing it will be seen that, where the steam method is to be applied to conveying large masses of concrete through a pipe-line of considerable cross-section for the purpose of lining a rough excavation, we may, if we so choose, use the machine as a spraying apparatus, and with its aid prepare the rock surface for the main concreting operation. The equip-

ment for both operations is, for the most part, precisely the same. In the one case, we would use a small flexible tube from the machine to about the point of use. In the other, we would take off the small tube and substitute the steel pipe-line with its covering of carbonate of magnesium.

It will be recognised that the steam procedure, whether used to spray concrete or mortar on to a surface, layer by layer, or whether used to place mass concrete in forms, involves a heated mortar or concrete. I quote the experience of the inventor: "I used 90 lb. in the mixing chamber and tried to have 50 deg. of superheat. Of course, as long as there is free water present superheat can be obtained; but, after the mixing had taken place, I seemed able to run the temperature up without any detrimental effects on the concrete; and there seemed to be no loss of strength."

The nozzle pressure is kept at about 45 lb. As the hose is lengthened, the pressure of the "atomiser" steam needs to be advanced—about 5 lb. for each 50ft. of hose.

The procedure has, it would appear, a good future from the point of view of spraying alone. There seems to be a growing tendency to encase in mortar or concrete steel work that is already in an erected condition. When sufficient provision is made to hold the envelope in place, the spraying operation becomes especially advantageous because of the ease with which layer after layer may be put on. Such provision will often consist of wire netting or expanded sheet steel. If there is little or no vibration to be endured, then nothing may be required to hold the layers in place. The spraying method affords an excellent way of dealing with the repairs of concrete walls. It is first necessary to clean out damaged places, removing all loose and disintegrated material. The concrete or mortar is then fired at the depression. In order that the operator may see clearly what he is doing when engaged on such work, it is very necessary that the steam shall show little or no vapour at the nozzle. The cloud of vapour should be at or near the wall. For repair work of this description, the process has been used successfully on the Delaware, Lackawanna, and Western Railroad. There a 2in. hose was employed in providing for the discharge. Acceleration was secured by a "nozzle consisting of a short piece of 1¼in. rubber hose choked down by an elliptical band." The force of men used consisted of two men feeding the machine, one man looking after its operation, and two men at the nozzle. Several other men were engaged in cleaning up patches, &c., and there was one foreman. The steam came from a locomotive, which also supplied the means of shifting the car or short train carrying the machine, &c.

Let us, in conclusion, consider a very important advantage which occurs when concrete is forced by jet on to steel surfaces in an "atomised" condition. At the very beginning of the application, both sand and the coarse aggregate rebound from the surface. For a while no substantial amount of anything else than cement grout sticks to the steel. The result is that the metal receives a coating of practically pure cement grout. I quote now from a recent authority on reinforced concrete construction, Professor G. A. Hool, of the University of Wisconsin: "In general, the rusting of iron occurs only under the combined action of moisture and carbon dioxide. A coating of Portland cement has long been known to not only exclude moisture and carbon dioxide, but in hardening to absorb any carbon dioxide which may be present." Integral with this jetting process—whether carried out by compressed air or steam—is the feature of providing a cement coating to steel and iron surfaces. This advantage belongs to any jetting process which really "atomises" the concrete and does not place it in a steam consisting in effect of a compact, coherent mass. The resolution of the concrete into its constituents and the intermingling of a relatively large quantity of a gas-like substance affords opportunity for grains of sand and pebbles to act individually. We get the rebounds because these considerable particles are not too closely hemmed in by a mass of material.

Views of a steam "atomising" and mixing plant are given herewith, while on page 164 are given three views, two of which represent the apparatus used in tunnel with compressed air, while the third shows the apparatus used with steam in the substructure of the Grand Central Terminus in New York City.

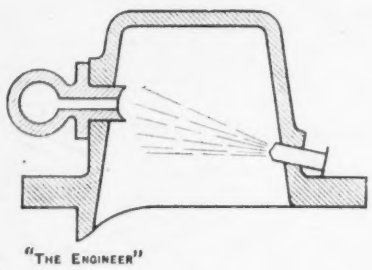


Fig. 1

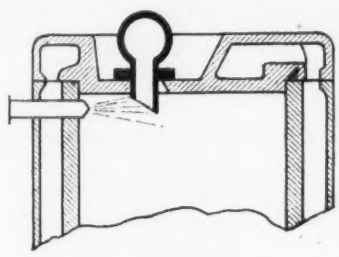


Fig. 2

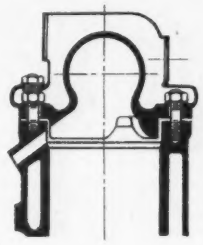


Fig. 3

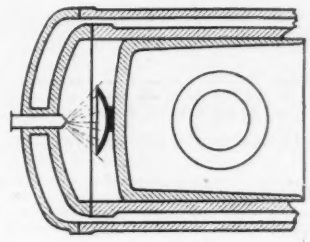


Fig. 4

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SOME BULB EXPERIMENTS ON HOT BULB ENGINES.

SIR,—Allow me to make some remarks in connection with the article published under the above heading in THE ENGINEER of August 10th.

Although your correspondent deserves a large amount of credit for his attempt to throw some light on this unsolved question of the right construction of hot bulbs, I venture to say that no actual or definite principle could be derived from his study in the way the investigation seems to have been carried out.

In addition to the reliability in working of engines of the class with which the author of the article deals, there are many other important factors which it is the aim of the engineers to combine for the sake of improving the working of these engines.

Mean Indicated Pressure.—In the two-cycle crank case compression engines the mean indicated pressure is unfortunately very low, say, from 35 lb. to 43 lb. per square inch, compared with 75 lb., and above, obtained in four-cycle hot bulb engines. In the two-cycle engines under discussion the scavenging air is supplied from the crank case at an initial pressure ranging from 3 lb. to 6 lb. The pressure at which the oil is delivered as "solid injection" varies from 600 lb. to 1500 lb. and even more. These two factors, scavenging pressure and oil injection pressure, have a preponderant influence on the proper combustion of the mixture and consequently on the mean indicated pressure. Your correspondent seems not to have taken these items into account, for he does not mention them, nor does he show any corresponding indicator cards.

Form and Volume of Bulb.—He has also discussed the very elusive question of shapes and dimensions of hot bulbs, without giving his views on these matters, which, I must confess, seem to be of much less importance than is generally believed.

Taking, for instance, the construction of the Swedish Scandia—Fig. 1—and of the American Mietz and Weiss engines—Fig. 2—the bulbs are about one-quarter the inside diameter of the cylinder, are spherical, and are connected to the cylinder by a narrow neck. The fuel injection takes place outside the bulb. Comparing these arrangements with the construction of the Robey engine—Fig. 3—quite a difference is observable, for the latter engine has a large bulb practically without neck or restricted connection with the cylinder. Comparing, moreover,

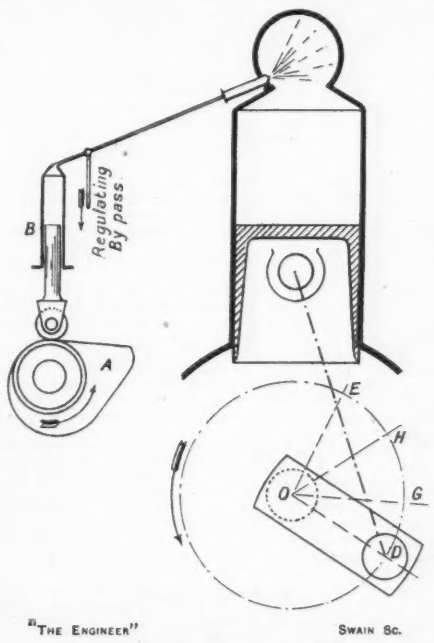


Fig. 5

the above constructions with some American two-cycle horizontal engines—Fig. 4—having no bulb at all, but provided with a "hot-plate" fixed on the piston against which the solid injection is made, it is remarkable to find that all these quite different designs lead to practically the same result in connection with consumption and mean indicated pressure. This leads one to conclude that, unless quite abnormal, the shape and dimensions of the bulbs do not, within noticeable limits, affect either the thermal or the mechanical efficiency in two-cycle engines of present design.

Method of Injection.—Your correspondent's interesting experiments were carried out with engines of different makes, viz., the Beardmore, the Bollinder, &c., each of them having a pulveriser of its own, arranged to suit the shape and location of the bulb. The experimenter concludes that the results obtained with the designs shown in his Fig. 3 were excellent, while those obtained with the designs shown in his Figs. 4, 5, and 6 were failures. It would therefore be interesting to know what he considers an excellent result, and at what load the result was secured: (*a*) Was it at half, full, or at momentary overload? (*b*) What was the corresponding mean indicated pressure on the piston? (*c*) What were the corresponding fuel consumptions? (*d*) What was the pressure of the fuel injection? (*e*) Was it obtained when introducing water into the cylinders, and at what ratio of the normal load? (*f*) What was the timing of the fuel injection?

As all those items play an important part in the output of the engine, their *rôle*, or influence, should be carefully determined before any conclusion could be derived from tests.

Pulveriser.—It is quite possible, for instance, that if the pulveriser of the design shown in the experimenter's Fig. 3 could have been applied to the designs as shown in his Figs. 4, 5, or 6, better results might have been secured from them, because the shape, the nature of the spray, and the moment it takes place might have better suited the form or the volume of the bulbs, and the length of their necks or connecting parts.

Shape of Spray.—It is obvious that the design shown in the experimenter's Fig. 3 requires a long spray only slightly diverging from the nozzle of the pulveriser, so as not to strike the lateral water-cooled wall of the neck but to attain its maximum state of pulverisation when reaching the bulb itself.

On the other hand, in his designs Fig. 4 and 5, and more especially in his Fig. 6, it will readily be understood that a short diverging spray reaching its maximum state of pulverisation soon after leaving the nozzle and evenly coating the surface of the bulb, will ensure best combustion.

Timing of Injection.—Moreover, the author does not mention whether he tried different "timings" in connection with each test. This point would have been of considerable interest, for there seems not yet to exist a definite understanding amongst engineers regarding the best moment to start and to stop the injection of the fuel in relation to the position of the piston along its compression stroke.

Everything being equal, it is admitted that the higher the pressure of the solid injection, the better the pulverisation; therefore it may be stated as principles that: (1) Whether driven by excentric or by cam, the supply of the fuel pump should always take place when the excentric or the cam has reached the position when the maximum velocity is imparted to the fuel. (2) The injection of the fuel should be completely performed before the piston reaches the end of its compression stroke, so that the full amount of fuel may be thoroughly burning before the expansion stroke starts, and so that the combustion should take place towards the period of maximum compression and temperature of the air in the bulb.

The regulation of the speed, or normal number of revolutions of the engine, being obtained through proportioning the amount of oil to the power developed, as mentioned, the next important question to be solved is the right moment of commencing and finishing the fuel injection. The same method of timing is not applied by every oil engine maker, and it seems as though three systems were in actual use when dealing with solid injection.

If illustrated diagrammatically in an arrangement of engine and fuel pump, the injection should take place within the limits of an angle D O E formed by the crank along the compression stroke, as shown in the accompanying engraving—Fig. 5—in which a cam A operates directly a fuel pump B.

The methods of solid injection consist in (*a*) starting the injection at a fixed point D and stopping it along the angle D O E according to the amount of oil to be injected, viz., according to the load; (*b*) starting and stopping the injection both at variable points for variable loads, say, from D to E for maximum injection, and from G to H for minimum injection; (*c*) starting and stopping the injection both at constant points, say, D and E, but varying the amount of fuel injected during the constant period; (*d*) starting the injection at a variable point along the angle D O E according to the load, but stopping at a fixed point E, say, for example, from G to E at three-quarter load, from H to E at quarter load, and so on.

The last-named method of timing evidently answers better the two methods set forth under Nos. 1 and 2, and seems therefore to lead to the highest efficiency.

Some contradictory results have, however, been recorded from actual application of the above methods, but this again may be due to the fact that the application of others of the required principles were disregarded, such as the proper pulverisation, the right position and temperature of bulbs, high compression, thorough scavenging, &c.

At this point it is worth while mentioning that the leading makers have endeavoured to get rid of the water injection in their hot bulb engines, for it is only an unreliable and defective expedient for recovering the power lost through faulty design of the combustion chamber and bulb.

Consumption.—The thermal efficiency of a well designed two-cycle hot bulb engine is still rather low, and the best results the writer has obtained by careful tests on certain engines of British make were about 0.51 lb. and 0.65 lb. of heavy oil of slightly more than 18,000 B.Th.U. per B.H.P. hour at full and at half load respectively. However, in actual practice, and after having run for some time, these engines have shown a very high consumption in lubricating oil, although they were under the attendance of the manufacturer's own engineer. The splash lubrication which is still applied in the two-cycle hot bulb engines, after it has been practically abandoned even in automobile engines, is largely responsible for this waste of lubricating oil.

Four-cycle versus Two-cycle Engines.—Moreover, the difficulty of inspection of the moving parts, and the chances of leakage of the crank case scavenging air, which hamper the good working of the whole engine, constitute drawbacks that have decided different American and European engine builders to develop the construction of the four-cycle hot bulb oil engines. Several leading English firms have specialised in the horizontal low speed hot bulb type, and, thanks to the high compression varying from 250 lb. to 300 lb. and above, they have secured fuel oil consumptions as low as 0.44 lb. per brake horse-power which is not far from the low consumption of the true Diesel engines.

R. E. MATHOT, M.I. Mech. E.

August 21st.

ERICSSON'S MONITOR.

SIR,—Apropos of my article on "The Revival of the Monitor" in your issue of last week, your readers may be interested in some additional facts relative to the original Monitor which were given by Mr. F. M. Bennett, an American engineer, in *Cassier's Magazine* for April, 1898. According to this authority, the model

TYPES OF IRISH LOCOMOTIVES.

By E. L. AHRONS, M. I. Mech. E.

The subjoined list gives the numbers and classifications of the locomotives in use on the Irish Railways in December, 1916, and applies to those of the broad or 5ft. 3in. gauge only. The list is made out in the same manner as were those in The Engineer for March 9th, 1917, which dealt with the engines on the railways of England, Scotland, and Wales only. The key to the classification will be found in The Engineer for September 17th, 1915. In addition to the above there are a number of light railways of 3ft. gauge, on which a very large variety of different classes are at work, totalling about 103 engines. Steam tramway engines and the three engines of the Listowel and Ballybunion Railway (Lartigue monorail system) are not included amongst these.

Irish Railways, 5ft. 3in. gauge, December, 1916.

	P 4 2	P 2 4 0	P 2 4 0	P 2 4 0	P 2 4 0 c	P 4 4 0	P 4 4 0	P 4 4 0 c	P 4 6 0 ×	B 2 2 2	C 0 4 2	D 0 4 2	C 2 4 0	D 2 4 0	C 2 4 2	B 0 4 4	C 0 4 4	C 4 4 0	B 4 4 2	C 4 4 2	C 4 6 0	G 0 4 2	G 0 6 0	G 0 6 0 c	G 2 6 0	G 4 6 0	S × 0 4 0	U × 0 4 0	S 0 6 0	T 0 6 0	U 0 6 0	S 0 6 2	S × 0 6 2	S 0 6 4	T 6 4	S 4 8 0
Belfast and Co. Down ...	—	—	—	1	3	—	—	—	—	—	4	—	—	—	6	—	—	—	4	8	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—
Cork, Bandon & S. Counties	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	2	—	3	6	—	—	—	—	—	—	—	—	5	—	—	—	—	—
Dublin and S.E.R.	—	1	—	4	—	—	6	—	—	2	2	—	12	—	15	—	—	—	—	4	—	8	11	—	—	—	2	—	—	—	—	—	—	—	—
G.N.R. (Ireland)	—	—	—	9	—	—	75	—	—	—	—	—	2	—	6	—	—	13	—	5	—	—	88	—	—	—	—	1	—	—	4	—	4	—	—
Gt. Southern and Western	—	—	4	8	—	4	81	—	1	—	2	1	—	—	7	17	2	—	—	14	—	—	136	—	11	6	—	1	16	2	—	2	—	4	2	1
Midland (N.C.S.)	1	13	—	5	8	—	2	20	—	—	—	—	2	2	—	—	—	—	—	—	—	—	14	2	—	—	—	1	—	—	—	—	—	—	—
Midland Gt. Western ...	—	—	—	32	—	—	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	68	—	—	—	—	—	17	—	—	—	—	—	—
Sligo, Leitrim & N. Counties	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	7	—	—
	1	14	4	59	11	4	186	20	1	2	8	1	20	2	34	17	2	15	4	34	6	8	319	2	11	6	2	3	35	2	5	6	2	15	2	1

Passenger tender engines, 4-coupled, 299
" " 6-coupled, 1

Passenger tank engines—
"Single" 2
4-coupled 137
6-coupled 6

Goods tender engines—
6-coupled ... 346

Goods tank and shunting engines—
4-coupled 5
6-coupled 67
8-coupled 1

In addition to the above the Waterford and Tramore Railway has four passenger tank engines, and the Cork and Macroom Railway five passenger tank engines. The Dundalk, Newry and Greenore (L. and N.W.R.) has six goods tank engines.

of a coast defence ironclad which Ericsson submitted to the Emperor Napoleon III. in 1854, and which was the archetype of the Monitor itself, had a turtle-back deck, and its turret was in the form of a hemisphere. This project, however, was never put into execution. When the contract for building the Monitor was awarded to Ericsson, it specified that masts, spars, sails, and rigging should be furnished, "of sufficient dimensions to drive the vessel at the rate of six knots per hour in a fair breeze of wind." As this requirement was totally at variance with Ericsson's idea of stability as applied to vessels of light draught, he simply ignored it, and apparently no attempt was made by the Department to enforce it, for the Monitor was a steamer pure and simple without masts or rigging of any kind. "Not many years later," Mr. Bennett observed, "the top hamper of masts and sails on a low freeboard turret-ship gave the British Navy the tragedy of the Captain." The upper part of the monitor was, in principle, a wooden raft surmounting the iron hull. Ericsson's own description of the vessel was "a fort on a raft."

The type of steam engine to which he was most partial was known as the vibrating lever type, by which a rocking or oscillating motion was changed to rotation by means of connecting-rods. It was first installed in the steamship Princeton in 1843, which had a half-cylinder engine with swinging "barn-door" piston. This was followed by double-trunk cylinders, and the final development was reached in the huge 100in. engines of the ironclads Dictator and Madawaska, the cylinders of which did not differ from ordinary practice, but still transmitted power by the rocking arms. Of the Monitor's steam plant Mr. Bennett wrote: "There were two return tube 'box' boilers, placed side by side, forward of the engines, each containing two furnaces, joined to the back combustion chambers by large oval flues. The height of the boilers from water-bottoms to top of shell was 9ft., from which it will be seen that they occupied practically all the vertical space between the deck and bottom of the ship. Each boiler discharged its smoke through a short uptake to a grated hole flush with the deck, there being no smoke pipe. The object of this was to avoid an obstacle to firing the guns. In all subsequent monitors smoke-pipes were provided.

Without air downtakes or ventilators, a mild forced-draught system had to be resorted to. This was supplied by two steam engines driving, by belting, two large blowers which discharged air into the engine and fire-rooms, whence it had no egress except through the furnaces. Air for the blowers was drawn from grated openings in the deck similar to those provided for the escape of smoke. The object of the gratings, of course, was to prevent missiles and débris falling into the blowers or boiler uptakes. Low iron coamings, or trunks, about 5ft. high, were provided to exclude water from these deck openings in a seaway. When cleared for action these trunks were to be unshipped, leaving the deck entirely clear, except for the pilot house."

With regard to the duel between the Monitor and the Merrimac, Mr. Bennett wrote: "As the first conflict between mastless steamers—engineers' ships—it will be interesting to remark briefly the part taken by men of the engineering force. The crew of the Monitor, including Chief Engineer Stimers, numbered fifty-eight. Of these, thirteen were officers. Five officers were of the line, or seaman branch; five were engineers; the others were the surgeon, paymaster, and captain's clerk. Twenty-one enlisted men were petty officers, seamen, and landsmen of the seaman class; seventeen were firemen and others belonging to the engineer class. The remaining seven were yeoman, stewards, and cooks. It appears that the fighting force—the men at the guns, in the magazine, and at the engines and boilers supplying power to handle the ship and the guns, were almost equally divided between the seamen and engineering branches."

The Monitor met her fate in a gale off Cape Hatteras at the close of 1862. In company with a new and improved monitor, the Passaic, she left Hampton Roads under tow, but using her own engines. The next night heavy weather was encountered, and water began to pour in under the turret and through the hawse pipes. "The water gained steadily and impaired the fires by swashing against the grate bars, until the falling steam pressure showed too plainly that the engines and pumps must soon stop. At 10.30 p.m. signals of distress were made to the vessel towing her—the Rhode Island—and that vessel undertook the dangerous and very difficult task of removing the crew by means of boats in the heavy sea, but before the work was done the Monitor sank. This happened soon after midnight in the morning of December 31st, 1862, about twenty miles south-south-west of Cape Hatteras. In Commander Bankhead's report of the disaster he asserted his conviction that a serious leak had been sprung by the pounding of the sea, separating the iron hull from the upper body, and this seems very probable."

It is interesting to note, with respect to the influence of the Monitor on naval construction in this country, that Sir N. Barnaby stated in his book "Naval Development of the Century," that the Devastation, Thunderer, Dreadnought, Inflexible, Ajax, Agamemnon, Colossus, and Edinburgh were all of the monitor type and grew out of the American system.

The Writer of the Article.

August 21st.

PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT.

Sir,—I have read with interest the four articles by Mr. Kenworthy under the above heading, and agree that it is high time this subject was brought into greater prominence. He raises many useful points, and while it is not the writer's intention to review the article as a whole, there are just one or two points which might be worth discussion.

It would seem that attention might have been called in Fig. 2 to the necessity for putting in sufficient rivets connecting the shaft to the gusset to give a bending moment equal to that developed by the anchorage. This may seem obvious, but is a common weakness, and the sketch shown, if to scale, is an example.

With regard to secondary stresses in Part 2, the method shown in Fig. 14 can hardly be commended owing to erection difficulties, and to the fact that it is based on the theory of continuous beams, which depends entirely on fixed supports, whereas the supports in this case are elastic (viz., trusses and girders) making the stresses almost indeterminate. In the writer's opinion secondary stresses can better be taken care of by the present method of detailing either by calculating their amount and providing for same, or studying the type of structure proportion of depth to span, &c., which give the least secondary stresses, and using such proportions in preference to those where percentage of secondary stress is higher. This subject is very well treated in the latest edition of Johnson, Bryan, and Turneaure.

It seems unfortunate that while dealing with this subject more stress was not laid on the necessity for a thorough grounding in first principles for men who are taking up this branch of engineering, together with definite positions, prospects, and remuneration for those who become proficient as distinct from the ordinary detailing draughtsman. There should be definite courses at our technical institutions for those who wish to specialise in the subjeot, as distinct from those who merely wish to have a smattering of the theory of structures as part of a general training in civil and mechanical engineering. In this connection it is interesting to read the American review to Mr. Cocking's book in the *Engineering News Record* of July 19th, 1917. This is written by Mr. Fleming, who is always broad-minded in his writings and unbiassed in his opinions. He writes: "It is against the implication that a knowledge of the calculus is not really needed by a designer of steel structures that the reviewer wishes to protest. Why do so many engineers and draughtsmen fear the calculus as children fear the dark? Nine-tenths of the problems involving the calculus that the structural engineer is likely to meet can be solved by formulas derived from the successive differentiation and integration of X^n. Mr. Cocking's methods of obtaining deflections and shearing stresses are ingenious, but a knowledge of the calculus is necessary to a general treatment of the subject; and an engineer who can use it will not be satisfied with the limited range of special cases. As Goodman truly says in 'Mechanics Applied to Engineering': 'Not one engineer in a thousand ever requires to make use of any mathematics beyond an elementary knowledge of the calculus; but anyone who wishes to get beyond the kindergarten stage of the principles that underlie engineering work must have an elementary knowledge. The labour spent in acquiring sufficient knowledge of the calculus to enable him to solve practically all the problems he is likely to come across, can be acquired in a fraction of the time that he would have to spend in dodging it by some roundabout process.' . . 'The reviewer has no wish to minimise the many excellent features of the book, but he thinks that an engineer or draughtsman with only a mastery of the book and the little knowledge it presupposes, is not sufficiently equipped to design steel frame structures other than those of the simplest kind.'"

The assertions he makes bring out truly the general tendency in this country of dodging problems by roundabout methods, and were among the points the writer wished to bring out in the correspondence referred to by Mr. Kenworthy in the footnote to his last article. The statements made in this footnote cannot be denied, and should be carefully considered by all who are interested in this subject. H. R. White.

London, August 17th.

PYRMONT BRIDGE.

Sir,—Referring to Mr. H. R. White's letter in your issue of the 9th March, I have pleasure in furnishing the following particulars.

When the ends of swing span are raised, the outer main girders are 103ft. 3¼in., 13ft. 1¼in. and 103ft. 3¼in. centres of supports, whilst under like conditions the inner main girders are 94ft., 31ft. 8in., and 94ft. centres of bearings respectively.

Separate calculations were made for each pair of main girders, the sections being proportioned in accordance therewith.

The analysis covered the following conditions:—

1. Dead load bridge swinging.
2. Bridge closed and ends raised 1¼in.
   - (*a*) Dead load.
   - (*b*) Live load at 100 lb. per square foot, advancing from right to left.
   - (*c*) Live load at 100 lb. per square foot, advancing from left to right.
   - (*d*) Live load at 100 lb. per square foot, covering whole of swing span.
   - (*e*) Live load at 100 lb. per square foot partial loading.
   - (*f*) Twenty ton concentrated load rolling from end to end of span.

The span is not designed to carry a live load when ends are floating.

The outer and inner main girders were calculated to have end deflections of 3.837in. and 4.023in. respectively, whilst the actual deflections in the work were ¼in. in excess of these figures. The ends of the four main girders are connected with a ⅜in. web plate 5ft. deep—Fig. 30, page 125, issue February 9th—which ensures the ends of the four main girders being raised to the same height.

The two transverse girders, carrying on their ends the two outer main girders, are 38ft. 8in. long overall, and 15ft. deep over angle bars. They are seated on the distributing girders "A," and have a span of 31ft. 8in. centres of bearings with an overhang of 3ft. 6in. from centre of supports—Figs. 47, 48, 49, and 50, page 150, issue February 16th. The outer bays are of web plate, stiffened with angle bars and plate standards over supports and a central bay of channel cross bracing—see page 105, issue February 2nd. At intersections with inner main girders the two transverse girders are solidly built into same, whilst flange plates top and bottom are provided to ensure the horizontal stresses being effectively carried through the whole length of top and bottom flanges.

From the foregoing it will be gathered that the two outer main girders are not carried by cantilever diaphragms hung from the inner main girders and supported at intermediate points on the distributing girder "A" with possible uplift on inner main girders; but are carried on two deep transverse girders with long riveted bearings and short overhang. These girders are so stiff that the deflection is negligible whether the ends of swing span be raised or floating.

Further, the small difference in loading on the distributing girders "A" and "B" is effectively distributed on the rollers by means of the stiff 5ft. deep drum carrying the top tread.

Percy Allan.

New South Wales, May 29th.

THE LATENT HEAT OF STEAM.

Sir,—I have read with interest the three articles on "Latent Heat of Steam," written by Mr. Aspinall, and recently published in your paper; and I also read your admirable editorial comments on the subject.

When I found a well-established theory and statistical table of figures attacked by an unknown student, I fully expected to see a shower of letters appear in the following issue of The Engineer, showing the fallacies, if not foolishness, of Mr. Aspinall. As no such letters have yet appeared, am I to understand that Regnault has no champions, or is it that you, Sir, have received the letters, but are keeping them back for some reason?

I believe that Regnault had his experiments verified by Lord Kelvin in the same way that Aspinall had his verified by Silvanus Thompson. It seems difficult to believe that two sets of experimenters such as these could have obtained such varying results if their apparatus had been similar. And if their apparatus differed, it is very likely that the condition of the steam that they were measuring differed also.

Aspinall has described his apparatus and the methods he employed to obtain his figures, but I believe it is very difficult to get hold of Regnault's original memoranda of his experiments. If you, Mr. Editor, could obtain these memoranda by any means, and publish them in your paper, I think it would be of great interest to the engineering world, and some of your scientific readers might be able to throw light on why the results should differ, and in a general way an advance might be made in a very important subject. Henry Sykes.

London, August 21st.

[Note.—We have withheld no letters on this subject.—Ed. The E.].

"PINCH."

Sir,—An immense amount of printing, engraving on pressure gauges, &c., would be saved if there were a word to express "pounds per square inch," corresponding to "bar" for "a megadyne per square metre." I venture to suggest the word "pinch" for this purpose. C. F. Dendy Marshall.

Guildford, August 20th.

Interest Chart.—We have received from Marsden and Co., Limited, Carr-street, Manchester, an interest chart, compiled by Mr. John T. Roy, of the same city. The chart is stated to be a speedy and accurate means of finding the interest due on any amount for any period at any one of fifteen different rates, ranging from 1¼ to 6¼ per cent. In our opinion the claim made for speed and accuracy is not fully justified, and we believe the chart will be found useful only as a means of arriving at an approximate figure, or of roughly checking a previous calculation. To use the chart the principal in pounds is multiplied first of all by the number of days for which it is at interest. The product is laid down along the horizontal scale of abscissæ, and the interest due is read off from the height of the co-ordinate up to the point where it is cut by one of eight straight lines radiating from the origin. Each such ray represents two rates of interest, one double the other. For the smaller rate the scale of co-ordinates on the left-hand side is used, and for the larger the twice-size scale on the right. The method is not speedy, because of the preliminary multiplication involved. In the example on the chart the interest on £1600 for 50 days at 2½ per cent. is worked out, and is stated to be £5 9s. 7d. The answer is correct, but it cannot be obtained from the chart. It is only possible from it to say that the interest is £5 9s. and something.

RAILWAY MATTERS.

The increase of 50 per cent. in railway fares put into force on January 1st last is not in operation in Ireland.

On the 15th inst. the President of the Board of Trade intimated that as at present advised he did not see his way to interfere with the toll payable by cabmen and taxi-drivers who used railway stations.

Between April and December of the year 1916 the sum of £13,333 had to be written off the books of the railways of India for material, rolling-stock, &c., supplied to Mesopotamia, which could not be traced.

It is stated that Sir Alexander Kaye Butterworth, the general manager of the North-Eastern Railway, is, at the instance of the Government, going to America to assist in industrial organisation in the United States.

A serious railway collision occurred on the 14th inst. near Raichur, Haidarabad. Five British soldiers were killed, and five British officers, two native officers, 30 British soldiers, one Sepoy, and several members of the train staff were injured.

In order to cut down coal consumption the Chicago, Milwaukee and St. Paul has shortened the stop of practically all its passenger trains at the stations on its system. At the same time the running times between stations have been lengthened, so that heavy firing is not necessary to keep the trains on scheduled time.

About forty passengers were killed on the night of the 7th inst. by the derailment of an express train from Genoa to Milan, at Arquata, Scrivia Station. As both the driver and fireman were killed, it is not known what was the cause of the accident, but for some reason the train was out of control at a point where there was a severe gradient.

The Alaskan Railway, now being built by the United States Government, is to be hurried forward, because its completion will hasten the development of its vast resources; will encourage the production of foodstuffs, thus reducing Alaska's dependence upon the United States for supplies; will furnish coal in unlimited quantity for the navy, obviating the necessity for the shipment of coal across the American continent to the Pacific, and, at the same time, release thousands of cars for the transportation of war materials and foodstuffs.

The Southern Railway Company handled approximately 18 million passengers during the fiscal year ended June 30th last without a single one being killed. Mr. Fairfax Harrison, the President of the Southern, ascribes this record not only to the greater human care and efficiency manifest in the operation of the road, but also to the improved facilities which have been installed during recent years. In conveying these passengers 71,775 trains and 249,780 cars were required. If the trains stood end to end on the tracks they would extend 5457 miles.

The Inter-state Commerce Commission has been authorised, under an Act passed on May 29th, to form a division of car service, and this came into being on July 12th. Its purpose is to deal with the movement, distribution, exchange, interchange, and return of freight cars, and this has been considered necessary in consequence of war needs. It is hoped that the division will have only advisory duties, as the railway companies have local car committees at twenty-five points who are in touch with similar committees of representatives of traders. The division itself will work with the Commission of Car Service of the railway companies sitting in Washington.

According to a paper read by Mr. Charles A. Newhall before the Pacific North-West Society of Engineers, a suspicious disintegration of the concrete lining of the Cascade tunnel of the Great Northern Railroad of America has taken place, probably due to the chemical combination of the sulphur in the locomotive gases with the cement in the concrete. The tunnel was lined with monolithic concrete in 1899, and was apparently in satisfactory condition until about 1915, when it was reported that pieces of soft white concrete had been found on the track and on trains. A general survey showed that concrete had disintegrated in places scattered throughout the entire length of the tunnel, though in no instance was it serious enough to impair the strength of the lining. On the concrete lining in the Seattle tunnel, which is eleven years old, being inspected, it was found that disintegration was in progress.

Asked on the 16th inst. by Mr. Fell if he could now say if the Government was in favour of the construction of the Channel Tunnel, provided that it was a condition that no work was to be done or money raised in connection with the tunnel during the war except with the consent and at the request of the Government, and that on these conditions the Government would support the Bill, when introduced, to give the necessary powers to link up the South-Eastern and Chatham Railway of England with the Chemin de fer du Nord of France, Mr. Bonar Law said:—The Cabinet have again carefully considered the question in consultation with their naval and military advisers, and they are still of the opinion that it is not practicable to proceed further with the matter during the continuance of the war. In these circumstances it would not be advisable for the Government to support a Bill of the nature indicated in the question.

The exact position as to the use by cabs of railway stations was well stated in the answer of Mr. Roberts to a question in the House on the 6th inst. That gentleman said that the charge of one penny was fixed by the Secretary of State under the provisions of the London Cab and Stage Carriage Act, 1907, which authorised the present practice in place of the privileged cab system to which strong objections had been taken by the cab industry. The Act followed the recommendations of a Departmental Committee in 1895, and of the Select Committee on the Cabs and Omnibuses (Metropolis) Bill, 1906. The representatives of the cab drivers supported the proposal both before the Select Committee and during the progress of the Bill. Asked as to whether, the railways now being under the Government, the latter could not step in and settle the matter, it was observed by Mr. Roberts that whilst the railways might be under the control of the Government they were not Government property.

NOTES AND MEMORANDA.

The shipments of molybdenite from the Province of Quebec during 1916 were 129,275lb., valued at 129,267 dols. The Quyon Mine, Pontiac County, is probably the largest producer of molybdenite in America.

The output of iron ore in Corea in 1916 amounted to 245,418 tons. The quality of the ore is poor, about 50 per cent. of iron, but the width and number of the veins more than compensate for the low quality. With improved transport facilities a very large increase in the output of iron ore may be anticipated.

The production of explosives in the United States during 1916 was in excess of 500,000,000 lb., an increase of about 44,000,000 over 1915. The total included 215,575,025 lb. of black powder, 253,154,787 lb. of "high" explosives, other than permissible explosives, and 34,685,240 lb. of permissible explosives. The value of the exported explosives, which in 1914, the first year of the war, were valued at about £2,000,000, reached a total value in 1916 of some £144,000,000.

About 51 per cent. of the salt produced in Russia is from lakes, 23 per cent. being obtained by evaporating brine pumped up from bore-holes, and 26 per cent. by mining beds of rock salt. Most of the rock salt comes from mines in the districts of Ekaterinoslav, Orenburg, and Erevan. Lake salt is obtained chiefly in the locality of Astrakan and Taurida, and boiled salt is produced in Perm district. In Western Siberia salt is obtained from a number of lakes which partially dry up in summer, and in hot years deposit crusts of salt from 2in. to 4in. thick. In Eastern Siberia salt is obtained from springs and from deposits of rock salt.

The quantity of "natural" asphalt, including bituminous rock, grahamite, gilsonite, wurtzilite, and the natural paraffin, ozokerite, produced and sold at mines and quarries in the United States during the year 1916, was 98,477 short tons, a gain of 22,726 tons, or 30 per cent., in quantity compared with 1915. The quantity of asphalt produced in 1916 by refining from crude asphaltic oils of domestic origin increased only 3½ per cent., as compared with that produced in 1915, and the quantity of similar material refined in the United States from Mexican petroleum increased 47 per cent., as a consequence of which the net gain over production in 1915 was nearly 20 per cent. California led all other states in the production of refined asphalt, its output from sixteen refineries in 1916 amounting to 257,930 short tons.

Little information, remarks the *English Mechanic*, seems to have been published on the acid-resisting properties of the iron silicon alloys, and our contemporary gives some particulars of an investigation undertaken by the American Electro-Chemical Society to determine their resistance to several common acids. Eighteen low carbon iron silicon alloys, containing 1.2 to 19.8 per cent. of silicon, were immersed from periods of fifty-one hours to twenty-nine days in 10 per cent. solutions of sulphuric, hydrochloric, nitric, acetic, and citric acids, and the losses determined. With a few irregularities the resistance to acid attack was a minimum at 1.2 to 3.3 per cent. silicon, and a maximum at 16 to 18 per cent. The latter alloys are very hard and brittle. Attempts are being made to find an additional element which will decrease these undesirable qualities without impairing the resistance to acids.

According to a recent report concerning the Pinghsiang collieries situated at An Yuan, Province of Kiangsi, China, there are now employed in the mines 10,000 men, 8000 as miners underground and 2000 in the surface works. There are two adits penetrating the mountain for a distance of 9383ft. in the case of the main, and 6726ft. in the case of the second adit. The main adit has been bricked for a distance of about 6562ft. Besides the adit there are two shafts, the first 625ft. deep, and the second 361ft. deep. The hoisting system is known as the Humboldt. Into the main adit and penetrating for a distance of something over 6562ft. there has been run an electric trolley line for the purpose of bringing out coal. Twenty-seven small electric locomotives are used on this line, six of 30 horse-power, twelve of 10 horse-power, and nine of 9 horse-power. *Eastern Engineering* says that they are all of German manufacture.

A paper relating to Irish water power was read recently before the Association of Municipal Authorities in Ireland. According to the *Journal* of the Royal Society of Arts, the author, Mr. McAndrew, estimates that 50,000 horse-power could be recovered for eight months in the year, and 20,000 to 40,000 horse-power during the dry season. Amongst the most interesting of Irish power schemes, however, was, Mr. McAndrew stated, the utilisation of the tide into and out of Strangford Lough, as proposed by Mr. A. W. Brown. This sheet of water has an area at low tide of about twenty square miles, while the entrance to the sea is only a quarter of a mile across in places, and could easily be dammed. It is obvious that an enormous amount of power is running to waste in this entrance, through which a huge volume of water passes four times in every twenty-four hours. Possibly as much as 100,000 horse-power might be obtained from this for twelve out of the twenty-four hours. The electricity generated thereby could easily be transmitted to Belfast.

Alloy steel castings for dies are being successfully used by drop-forging manufacturers in America. The most satisfactory alloy yet used, says the *American Drop Forger*, is vanadium-carbon steel, with a fine close-grained structure. The use of vanadium gives the necessary combination of toughness and hardness with exceptional wearing qualities and resistance to cracking. A run of 40,000 motor-brake support forgings was, for example, made from a pair of cast-steel dies without any great amount of wear. For general drop-forge work the best practice is to cast the dies with the tenons and with the impressions for breakdowns approximately to shape, allowing a small amount for finish. The impression for the die is then sunk in the solid block. For plain forgings, the impressions also are sometimes cast in the dies, allowing some metal for finish. Cast vanadium-steel dies, when properly annealed by the foundry, can be machined without much difficulty. After being machined the general practice is to heat the dies to 1550 deg. or 1575 deg. Fah., and quench in oil, and in most cases no further heat treatment is required.

MISCELLANEA.

According to the *Army and Navy Journal*, New York, the U.S Machine Gun Board has approved of the Browning automatic rifle, and has recommended the purchase of 20,000 of these. The American army will also make extensive use of the Lewis gun.

Aragam Bay is expected to become the leading port on the East Coast of Ceylon. It is stated that a big scheme has been prepared to put up the necessary buildings, &c., in connection with it, and that the Public Works Department is constructing a road to it.

The Town Council of Harrogate has decided to make application to the Local Government Board for sanction to borrow £4710 for the installation of a by-product steam boiler plant, in accordance with the designs and specification of the borough electrical engineer.

Early reports of the fire which took place at the works of the India Rubber Company, Silvertown, on the 11th inst., appear to have been greatly exaggerated. Comparatively little damage was caused, and there was, we are informed, practically no disturbance to the manufacturing operations in the building involved.

In view of the urgent demand for increased aero engine or aero engine parts production, as supported by the maximum priority given to this class of work, it is of the greatest national importance that any firms which consider they are in a position to render assistance, should write to the Controller of Aeronautical Supplies, Room 355, Air Board Office, Strand, W.C. 2.

For the last batch of submarines the U.S. Navy Department endeavoured to dispense with the air-starting valves for the Diesel propelling engines, the main idea apparently not being to do away with the air compressors, but to simplify the cylinder-head construction, and reduce the number of orifices in the casting, thereby assisting to prevent the cracking of the heads, says *Motorship*.

It has been decided to carry out improvements of the Port of Antofagasta in Chili at a cost not exceeding £1,700,000. Details of the work to be performed and the conditions of contract may be obtained from the Port Commission Offices in Santiago, and copies are expected to be received shortly at the offices of the Chilean Legation in London, 22, Grosvenor-square, W. 1. Tenders will be received up to 3 p.m. on March 30th, 1918, by the Minister of Finance, Santiago.

An objection to existing types of concrete fence posts has been the lack of a suitable means of fastening wire fencing to the posts. A scheme to overcome this is described in the *Contract Record*, Toronto. A strip of tar roofing paper, 1¼in. wide and ⅛in. thick, is inserted in the face of the post. It is claimed that the tar paper is very suitable for this purpose, as it does not expand and crack the concrete in the first stage of setting and remains seated in its bed without contraction.

According to the *Autocar*, it is reported from New York that a Mr. Louis B. Cherry has invented an electro-chemical process for producing synthetic petrol from kerosene or paraffin at a cost of ½d. per gallon. The process is described as "a successful application of the electro-magnetic theory of matter by mixing hydro-carbides." It is also announced that an experimental plant capable of converting about 60,000 gallons per day has been established, where 78 per cent. of the petroleum treated has been converted into petrol of a sufficiently high quality to be suitable for the engines of motor vehicles.

The *Times* Christiania correspondent has telegraphed particulars of the launch, at the Porsgrund Cement Works, on the 20th inst., of the first Norwegian iron and concrete ship. The vessel, which is of two hundred tons burden, was built with its bottom upwards and, apparently, on a sort of underlying sledge or cradle which went down into the water with the vessel. The latter is reported first of all to have become detached from its cradle, then to have sunk up to a certain point, and then gradually to have righted itself. It is said that it only took three weeks to build the boat, and that the next vessel will only require about half that time.

In the addressing of envelopes on a typewriter a considerable amount of time and labour is expended in feeding the envelopes into the machine. This ordinarily requires three operations: Picking up an envelope from a pile, placing it in the machine, and straightening it. The *Scientific American* alludes to a device which has recently been introduced in the United States, and which fits all machines and is sold at a reasonable price. This apparatus automatically feeds envelopes into a typewriter, one by one, each in perfect alignment. It takes one hundred or more envelopes at a time, and feeds them automatically, so that there is always an envelope in position.

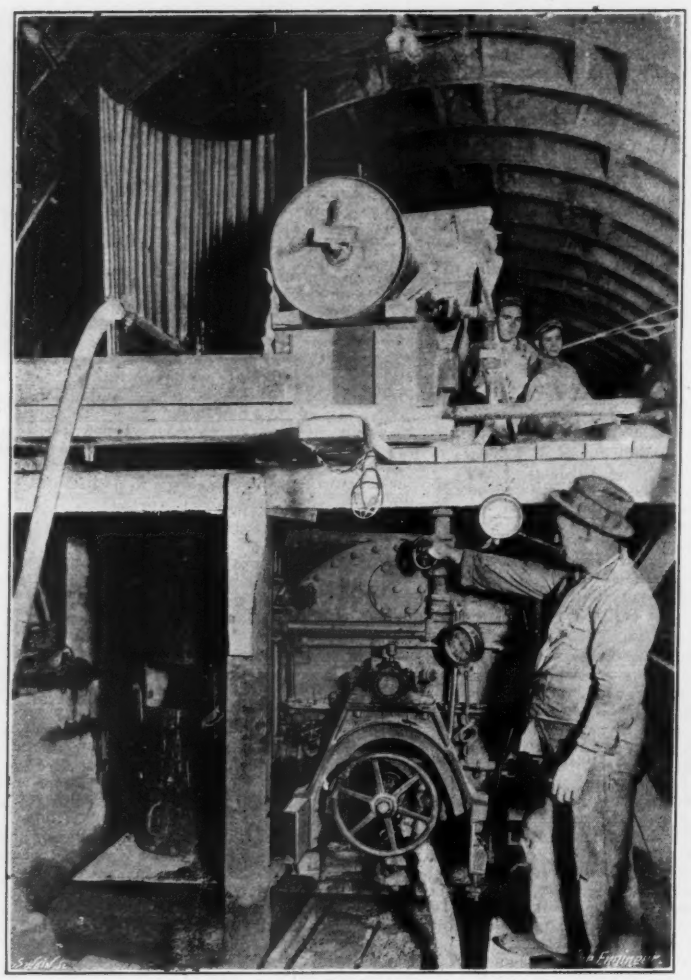
The Asano shipbuilding yard at Tsurumi, Japan, has, says *The Indian and Eastern Engineer*, taken up the construction of four steamers ordered by the Tatsuma Steamship Company, the Suzuki Company, and the Toyo Kisen Kaisha, each of 11,000 tons. The new yard covers an area of 280,000 tsubo—a tsubo being equal to six square feet. Arrangements are, it is said, being made to enable the yard to construct ten vessels at the same time. Nearly all machinery in the yard has been obtained from Japanese establishments, and it is estimated that during this year vessels representing 114,000 tons will be built. In future the yard will undertake the construction of warships, in addition to merchantmen.

Lancaster is contemplating a large scheme for increasing its water supply. According to the *Architect and Contract Reporter*, the scheme comprises the construction of three storage reservoirs at Langthwaite (to hold 135,000,000 gallons), Lower Damas Gill (100,000,000 gallons), and Sparrow Gill (200,000,000 gallons), and an additional compensation reservoir at Wyrehead, capacity of 135,000,000 gallons. The present gathering ground is to be utilised to the full, and another line of pipes laid. The cost of works alone is estimated at £400,000, and it is proposed that the first instalment of the scheme, which will probably cost £250,000, should include the construction of the new compensation reservoir and one new storage reservoir, the present storage accommodation being confined to Damas Gill (35,000,000 gallons) and Blea Tarn (126,000,000 gallons).

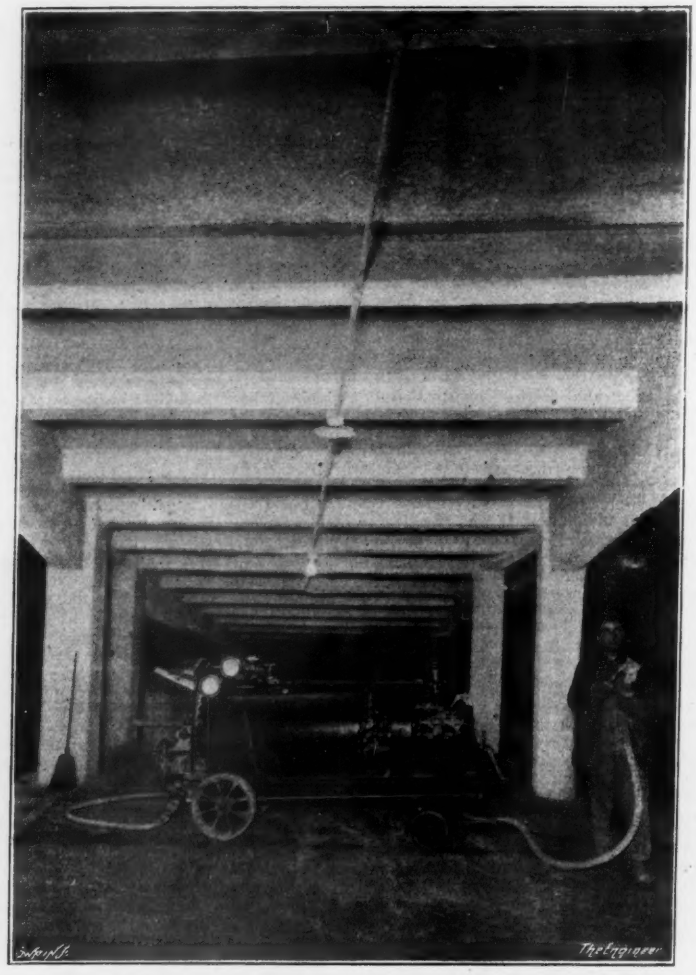
APPARATUS FOR CONVEYING AND APPLYING CONCRETE

(*For description see page 159*)

CAST IRON LINING OF NEW SUBWAY AT NEW YORK RECEIVING APPLICATION OF CONCRETE



NEW SUBWAY AT NEW YORK—CONCRETE ATOMISING AND MIXING APPARATUS



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THE ENGINEER.

AUGUST 24, 1917.

The Railway Enginemen's Demands.

EARLY on Wednesday morning it was announced that an understanding had been arrived at between the President of the Board of Trade and the Executive Committee of the Associated Society of Locomotive Engineers and Firemen, with the result that the society had agreed not to call out the engineers on strike this week. For no small amount of the recent unrest in the labour world there has been some justification. For the threatened strike of some of the railway drivers and firemen there would not, however, appear to have been any good cause. Even were there no war, and had peace conditions prevailed, this remark would still apply, because it is apparent, from the public statements of the officials of the enginemen's society, that the whole trouble arises from the jealousy of a smaller trades union over the success achieved by a larger body. The smaller society concerned is the above-mentioned Associated Society of Locomotive Engineers and Firemen, which, at the end of 1916, had a membership of 34,039, or three-fifths of the total number, 57,212, of the drivers and firemen employed, according to the Board of Trade accident returns, at the end of the year 1915. The other society is the National Union of Railwaymen, which, at its recent annual meeting, reported a membership of 340,511. As the total number of railway servants eligible for membership in these two unions is about 550,000, it will be seen that the National Union has about seven-tenths of the remainder of the eligible members. In this connection it must not be forgotten that the men represented by the Associated Society are the most technical grades, and they pride themselves on their important place among railway employees, and, as was remarked at the time of the railway strike of 1911, "when they stop the whole system stops." This feeling of superiority is not of recent growth; it has long been evident. It was, for instance, revealed when the Royal Commission of 1911 on the Railway Conciliation Scheme was hearing evidence. The locomotive men complained that their grievances were heard and adjudicated upon by boards in which were included representatives of porters, ticket collectors, and lampmen, who often outvoted the locomotive men in order to leave the field clear for their own claims. The witnesses for the Associated Society therefore opposed the Amalgamated Society of Railway Servants' proposals on that occasion. The former wanted matters dealt with sectionally, as they were likely to receive greater benefit from a purely locomotive board than from a mixed body of differing grades. Coupled with these divergent views there is another important factor in the present situation, namely, the greater growth of the National Union. In 1913 that body was formed out of three existing societies, the chief of which was the Amalgamated Society of Railway Servants, which had a total membership when the 1911 strike occurred of 86,000, as compared with 19,800 in the Associated Society. The National Union has therefore had, roughly speaking, twice as great an increase in membership within the last six years as has had the smaller body, and this increase is likely to be considerably augmented by the proposed incorporation also of the Railway Clerks' Association.

The recent trouble arose from a demand of the enginemen that they should have an eight hours' day. This, it should be noted, is not a new demand, nor did it emanate originally from the Associated Society. For many years it has been a plank in the platform of the National Union and of its predecessor, the Amalgamated Society; but it had been recognised as one impracticable of accomplishment when, in October, 1914, representatives of the two societies and of the companies made a truce as to no applications for higher wages or improved conditions being put forward until after the termination of the war. Despite this truce there have been applications made for higher wages, but these have been on the ground of the increased cost of living, and on this ground concessions have been granted on five occasions, the last being only three weeks ago, when the war bonus was converted into wages. This had the effect of overtime and Sunday duty being calculated at an increased rate, thus adding about three millions a year to the twenty-two millions the bonus was costing. In these applications both unions joined and benefited, but, owing to the greater influence that the Executive Committee of the National Union could bring to bear, most of the credit for the concessions obtained should perhaps be given to that body. This, of course, is very galling to the other union, the standing of which is likely to be adversely affected as a consequence; and it is possibly this fear that led to the Associated Society refusing to accept the latest concession, and to ask for an eight hours' day instead. The situation, were it not so serious, would be amusing. It is hard to imagine such a change being made at the height and the most critical period of a great war, and at a time when the railway companies have parted with such a large number of their servants, including many drivers and firemen, to assist in various ways in this great struggle. Where, it may be asked, are the additional men to be found who would be necessary should an eight hours' day be established? Before the settlement was arrived at the officers of the Associated Society would appear to have recognised that they had entered upon an impossible situation, so they changed their ground and asked, in place of their original demands, that the principle of the eight hours' day be conceded. To this the President of the Board of Trade replied that he pledged the Government, the War Cabinet, and himself personally, to continue the present control of the railways for some time after the cessation of hostilities, so that there would be an opportunity afforded within one month to bring forward a request for a shorter working day while the railways were under control, and he promised that any reasonable request for a shorter working day would have the immediate and sympathetic consideration of the Government.

Railwaymen deserve well at the hands of the Government. They have not only been of the most valuable assistance in the conduct of the war, but have safely and satisfactorily carried out the great task that has fallen upon them. They deserve well, too, because the conditions of service have prevented them from going to other occupations in which they might have earned more money. That these sacrifices by the men have been appreciated is shown in the readiness with which wage and other concessions have been granted. The men have had to work long hours—Sir Albert Stanley said so in the House a few weeks ago—but the conditions which have brought about the necessity for these long hours have been very abnormal, and the overtime in most cases has been unavoidable. The enginemen, though, are not alone in this respect; shunters, goods guards, foremen, signalmen, passenger guards, checkers, and every other rank have had to share in the discomfort. The enginemen—or at least their trades union leaders—make much of the strain upon them. Whilst not desiring in the least to suggest that a driver has not a great strain and responsibility placed upon him, we would claim that the strains are of short duration, and not continuous like those that are experienced by signalmen and shunters who are "on the go" the whole of their tour of duty. All drivers get more or less frequent stoppages, which alleviate the strain; the worst cases are those of the long-distance expresses, but the drivers of these get two or three hours' rest after their two hours or so's run. We might point out other weaknesses in the men's case, but there is no necessity to argue the point. We believe that the men's leaders realised that their case was a bad one; they were not supported by their fellow-unionists, and we doubt if their own society was wholly with them. Certainly the public was against them. Let them, we suggest, take warning by this last, and by the firm attitude of the Government, and be content with the good concessions already given them, with the promise of the President of the Board of Trade—himself a railwayman—to look into the question when the war is over; and let them remember the satisfaction with which the country has hitherto regarded the good work the enginemen and railwaymen generally have done.

America's Shipbuilding Problems.

MANY circumstances combine to keep prominently before us the vital importance of the shipping question. Though submarine piracy has utterly failed to justify itself as "the best and only means of a speedy victorious ending of the war," as the Germans last February claimed it to be, the Admiralty's weekly

returns of shipping losses remind us that the menace to our lines of communication continues to be grave. The belief that some sovereign remedy for the submarine will be discovered is cherished only by people who are without knowledge of naval technique. The practical view is set forth in the message recently addressed by Admiral Jellicoe and Sir Edward Carson to the Iron and Steel Trades Confederation: "There are only two weapons that we can use, and both can only be forged in the shipyards of the country. One is the class of warship that enables the Navy to hunt and destroy the enemy's submarines; the other is every new merchant ship that takes the place of a ship that has been sunk." In this country the output of both types is now very large, and everything possible is being done to expand it still further. The figures which Mr. Lloyd George gave in the House of Commons on August 16th were distinctly encouraging. If present anticipations are fulfilled, the total output of shipping in 1917 will reach nearly two million tons, which is practically the average of a normal year. At the same time, said the Prime Minister, our naval construction will also be increased by several hundred thousand tons. France and Italy are engaged in similar work to the full extent of their shipbuilding capacity, though both countries are handicapped by shortage of labour and raw material. America is more favourably situated, and it is to her that the Allies look for the largest contribution in new tonnage. The essential facts of the shipping position were laid before President Wilson's Cabinet by the British mission which visited Washington a few months ago. Shortly afterwards a huge programme of emergency construction was framed by the Shipping Board and authorised by the President, and it was expected that the vessels would be put in hand without delay. The plan was to build one thousand cargo vessels of moderate size and speed, the majority being of wood, and two standard designs were prepared with a view to simplifying the construction. The form of hull adopted, with its virtual absence of curves, would have enabled most of the work to be done by ordinary carpenters. The projected vessels had no pretence to beauty, but their seaworthiness was attested by the approval of the underwriters and their designed speed of 10½ knots was considered adequate for the work they were intended to do. Meanwhile, the Emergency Fleet Corporation, a sub-department of the Shipping Board, had been collecting and tabulating a great mass of information relative to the building facilities available on both coasts, and the capacity of the engineering firms to manufacture the propelling machinery for the wooden ships. The result of this inquiry showed that no difficulty need be apprehended in building and equipping one thousand vessels in a very short space of time. Ten firms alone pledged themselves to supply 496 vessels of the standard design in twelve months, and 786 in eighteen months, while the seventy-five smaller yards on the two coasts which specialised in wooden construction were capable of turning out several hundred more. At this juncture, however, doubts arose as to the expediency of building such large numbers of wooden vessels, and General Goethals, as head of the Emergency Fleet Corporation, gave it as his opinion that steel ought to be substituted for wood. The controversy which followed ended in General Goethals resigning his position. Apparently, a compromise has since been effected, for the latest advices indicate that the cargo fleet will comprise both wooden and steel ships, in addition to others built on the composite system. Moreover, steam machinery will be widely used in place of the internal combustion engines with which it was at first proposed to equip all the new vessels, and we understand also that the dimensions and speed will be substantially increased. Thus the ships to be built under the modified plan will be superior in many respects to those originally projected, though it is to be hoped that the change will not involve undue delay in the execution of the programme.

Mr. John Birkinbine, a consulting engineer attached to the Department of the Interior, has published some instructive data concerning the task which this great scheme will impose upon American industry. He considers that if the United States, in addition to its normal yearly output of one and a-half million tons of shipping, can launch three millions deadweight carrying capacity, her contribution to the common fund of Allied tonnage will be ample. This total would require an approximate weight of three million tons of steel for the hulls and machinery, including 500,000 tons of structural shapes, and 1,500,000 tons of ship plates. His estimate is based upon the assumption that the new vessels will differ radically from the conventional type of slow cargo steamer with a deadweight carrying capacity of 10,000 tons and mediocre speed. Speed is now recognised as an important element of protection against submarine attack, and expert opinion in America consequently favours a minimum speed of 15 knots for all vessels intended to traverse the danger zone. But every extra knot means a considerable increase in the weight and area occupied by the driving plant, with a corresponding reduction of cargo space. It is, we think, a debatable point whether the sacrifice of carrying capacity—which might be as high as 50 per cent.—entailed by raising the speed from 10 to 15 knots is compensated by the supposed increase in the factor of safety. There is evidence that the sea speed of the later German submarines is much higher than that of the boats which operated earlier in the war, and it is open to doubt whether a 15-knot steamer is much more immune from attack under present conditions than a slower vessel would be. To build a vessel of 15 knots speed and 5000 deadweight capacity would require about 850 tons of structural steel and 1750 tons of plating, and as the American yards expect to launch six hundred such vessels within a year, the steel industry will be called upon to provide 510,000 tons of frames and over one million tons of plating. As the normal yearly output of frames is three million tons, the extra 510,000 tons would represent an increase of 17 per cent., while to the normal yearly figure of 2,400,000 tons of plating must be added 1,050,000 tons, or an increase of over 40 per cent. It is pointed out by Mr. Birkinbine that, in addition to the increased production of frames and plates on the one hand, and of engines and boilers on the other, account must be taken of the extra structural work in the building and extension of mills, furnaces, cranes, manufacturing shops, punching and shearing machines, together with the necessary additions to the plant of the various shipbuilding yards. Then, again, mining operations will have to be conducted on a far larger scale than hitherto in order to supply the requisite increment of ore, fuel, flux, and refractory materials, and this, in turn, will mean a great extension of the structural steel and machinery in use at the mines and quarries. Finally, the problem of transporting all these raw materials, half-finished and finished products from mine and quarry to foundry, from foundry to shop, and from shop to shipyard, will place a heavy burden on the railway system, and render necessary an increase in the supply of rails, bridges, rolling stock, &c. "All these supplementary needs," says Mr. Birkinbine, "predicate a greatly enlarged productive capacity for our steel plants. Our normal consumption of steel products cannot fail to increase, rather than diminish. We must supply our Army and the armies of our Allies with equipment, munitions, and material. And this immensely increased demand will fall not merely on our present industrial facilities, but on the various manufacturing organisations, and peculiarly on labour. Complete, effective performance of the varied and complicated task demands co-operation of the closest kind on the part of every factor in that essential triangle—Government, labour, and capital." In ordinary times about 5,400,000 tons of structural shapes and plates are produced every year in the United States. To build an additional six hundred cargo vessels this total must be expanded by 1,500,000 tons—a net increase of nearly 30 per cent., to which must be added a further 20 per cent., represented by the supplementary needs of the mines, foundries, railways, &c., specified above. In all, therefore, the output of steel will have to be increased by some 50 per cent.

From the foregoing facts and figures we are able to form some idea of the magnitude of the task which now confronts American industry, more particularly that branch of it which is concerned with the production of steel. It offers a wonderful field for that organising genius, and that readiness to cope with extraordinary demands on which the American captains of industry have always and justly prided themselves. In so far as shipbuilding is concerned, we are confident that our American Allies will prove equal to every demand made upon them. Already they realise that, in the phrase of Mr. Lloyd George, "ships, ships, and more ships" is the watchword of victory. A month or two of precious time may have been lost in discussing the respective merits of wood and steel, but now that a decision has been reached there is every sign of a determination to tackle the problem with true American energy. This month of August—or was it not July?—was, according to official German predictions last February, to witness the total collapse of the Allies through the severance of their maritime communications. What, on the contrary, is the position to-day? The arrivals and clearances of sea-going ships at our ports show no appreciable reduction. Foodstuffs, munitions, and raw materials continue to arrive, if not in unlimited quantities, at all events on an adequate scale. It is true that ships are being sunk week by week, but against this steady depletion of the tonnage originally at our disposal we can set the great activity that now prevails in the shipyards of the United Kingdom, France, Italy, and the United States, an activity which, a few months hence, will result in large additions to the cargo-carrying fleet of the Allies. We confess that, after reviewing all the facts of the shipping situation, we can find no grounds for pessimism, but rather many sound reasons for supreme confidence in the ability of the Allies to circumvent the most desperate efforts of the enemy. Submarine piracy was initiated by Germany with the dual object of inducing a speedy and favourable peace, and of eliminating future competitors in the struggle for maritime commercial supremacy, which she anticipates will begin immediately after the cessation of hostilities. By the irony of fate its effects bid fair to be precisely the opposite of what were intended, for not only are the Allies more than ever resolved to prosecute the contest until Germany has made full restitution for all the crimes she has committed, but the wholesale destruction of tonnage has given an impulse to shipbuilding in the United States which is likely to survive the present crisis and to re-establish the American mercantile marine on a scale that will make it a most formidable rival to German shipping after the war.

LITERATURE.

All the World's Aircraft, 1917. Founded by the late F. T. Jane, edited and compiled by C. G. Grey. London: Sampson Low, Marston and Co., Limited, 21s. net.

Great changes have been wrought in this annual publication since the death of its founder, and, on the whole, we feel bound to say that under Mr. Grey's expert editorship the interest and value of the book have been considerably enhanced.

A new feature is an aeronautical dictionary of technical and slang terms. The definitions of the technical terms are inclined to be scrappy and are not always strictly accurate, as, for example, in the case of centres of gravity, pressure, drift, thrust, &c., where these centres are defined as *lines* instead of as points. The definitions of the slang terms are much more interesting and valuable. They are, however, frequently marred by heavy attempts to be humorous. The slang which has grown up round the practice of aviation is considerable and curious, and the effort here made to record and explain it for the benefit of the general public is commendable in principle.

An article entitled "Aircraft in War," by Captain W. E. de B. Whittaker, forms as it were a general introduction to the book. It is pleasantly written, but contains nothing new of any great interest. Thereafter follow in alphabetical order particulars and photographs of the world's principal aeroplanes arranged on a national basis. The illustrations are nearly all reproduced from photographs, outline scale drawings being few. We naturally turn to the British and German sections with chief interest. So far as the British section is concerned, we can safely say that the information it contains gives nothing away to the enemy. As for the German section, the information and illustrations given are surprising in more than one sense. Through the policy of the French Government of publishing as full particulars as possible of all new types and modifications of German machines immediately such particulars become available through capture or other means, quite a considerable amount of detailed information regarding our enemy's aeroplanes is made publicly available. Full advantage of this has been taken in this year's volume. The German section is, however, surprising in another respect. The careful reader will find at the foot of page 149*b* a note intimating the fact that "the descriptions of many of the German machines have been written by a distinguished foreign student of aeronautics, and have been deliberately left in their original form." We did not discover this note for some time, but we readily came to the conclusion which it embodies. Why on earth Mr. Grey chose to leave the descriptions in their original form we cannot guess, but we feel bound to protest that to have done so was fair neither to the distinguished foreign student nor to his readers. The phraseology has not even the poor quality of quaintness to justify its retention. Here is a sample, taken from page 169*b*—the context has no bearing on its meaning:—"So 'Walfisch' (whale) as the idea coming to one may be the coming nomenclature of German aircraft as 'Taube' was in the earlier part of the war." On page 167*b* we read:—"This feature led to quantity manufacture early in the war, when the Allies had not too plenty of aircraft, so that the Fokker campaign cost for some months, starting October, 1915, some loss of 'Fokker Fodder,' most of the German star turns, who manned the Fokkers, going however out in the end, like Boelcke, Immelmann, Wintgens, &c." There is no excuse for permitting jargon such as this to appear in a technical work of reference even in war time.

Following the aeroplane section there comes one devoted to the world's airships. It opens with an

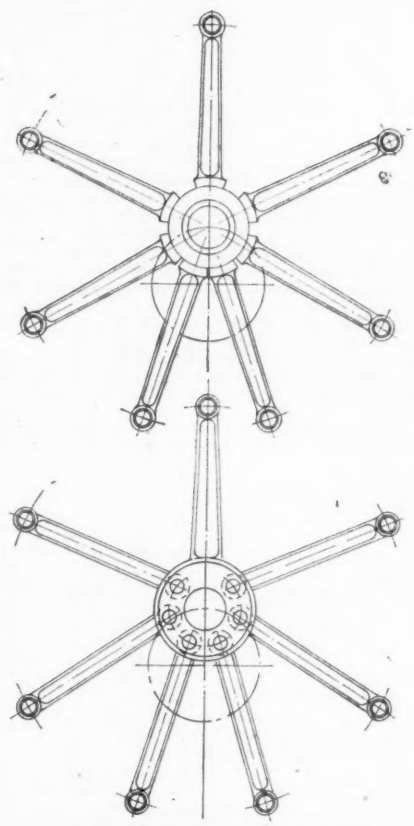
article entitled "The Airship—Past and Present," by Mr. W. L. Wade, and is very largely of historical interest only. Practically no information is given relating to airships other than those existing at the outbreak of the war. We state this, not by way of criticism, but as a mere matter of fact, for we are aware of the difficulties facing the publication at this time of anything like a satisfactory record of the world's airships.

The next section is devoted to aero-engines, and is prefaced by a readable article on aeromotor development in 1916 by Mr. G. de Holden-Stone. The last section of the book is a collection of particulars and illustrations of historical aircraft. It includes two articles, one by the Countess of Drogheda entitled "War Balloons and Parachutes," and the other "A Brief History of Modern Aeronautics," by the editor.

AERO-ENGINE CONNECTING-RODS.

By P. G. BOURCIER, Ing. A.M.

THE present tendency in petrol engines for marine and aerial work is to group two or more connecting rods to the same crank pin. The systems employed may be divided into two classes—the radial class of connecting rods, in which all the rods are connected radially to the crank pin—see Fig. 1—and the out-of-centre or master-and-auxiliary class, in which only the master rod is connected radially to the crank pin, the auxiliary rods transmitting their thrust through pin



Figs. 1 and 2—CONNECTING ROD SYSTEMS

joints attached to the foot of the master rod—see Fig. 2. The writer has for some time past been investigating the question as to why so many of the master rods of a certain design of radial engine broke when on test, and has drawn some conclusions that may be of interest to those engaged on the design of light high-speed engines of the radial or vee type.

It should be remembered that no rigid connection exists in such an engine between the gudgeon pin and connecting-rod, or between the piston and cylinder walls, clearances being allowed in assembling which increase by reason of wear. It should also be noted that ignition is not instantaneous, and that pre-ignition does take place occasionally. It is therefore justifiable to make the assumptions on which the present argument is based, more particularly those with reference to shock and vibration of the connecting-rod.

A set of out-of-centre connecting rods for a seven-cylinder radial engine of standard design was taken for the purpose of exact investigation. The moment of inertia of the master rod about the gudgeon pin centre was calculated. The result was then checked by swinging the rod as a pendulum about the same centre, eliminating friction as far as possible. The two results were found to agree closely. It was found that the centre of gravity was 21 centimetres from the gudgeon pin centre, the radius of gyration 22.8 centimetres, and the centre of oscillation 24.8 centimetres from the same centre. The radius of gyration about the centre of gravity was found to be .895 centimetres.

In Fig. 3 let C D be the master rod, A B one of the auxiliary rods, G the centre of gravity, C K the radius of gyration, P the centre of oscillation, all about the centre C. When the explosion takes place on A B for an ignition advance of 30 deg. the master rod, which has an angular swing, is struck at a point E. The effect of this on the master rod will now be studied.

Taking the moments about centre C, and applying the d'Alembert theorem on the motion of the centre of mass, and equating the accelerations thus found, we have

$$\text{Reaction at C} = \frac{F\,(E\,G \times C\,G - k^2)}{k^2 + C\,G^2}$$

where k = radius of gyration about G. Taking an

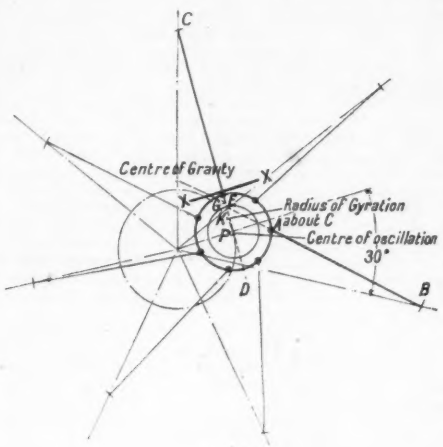


Fig. 3

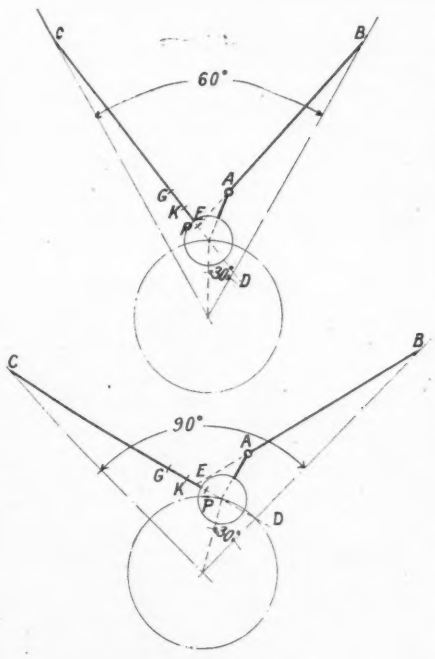
explosion force of 5000 lb. on A B the reaction at C will be

$$\frac{5000 \times \cos 33 \text{ deg. } (.05 \times 21 - 8.95)}{8.95^2 + 21^2} = 636 \text{ lb.}$$

This reaction will be of opposite direction to F since E G × C G is less than k^2.

Treating the master rod C D as a cantilever loaded at C with 636 lb., and held on the crank pin, the stress at section XX is found to be 36,000 lb. per square inch. This must be doubled if the load is treated as a shock. Figs. 4 and 5 illustrate the same principle applied to vee engines.

It might further be assumed that the clearances render possible a vibration of the rod under the shock, the periodicity of which could be determined. It might then be investigated whether the vibrations corresponded with that arising from another shock



Figs. 4 and 5

due to a following explosion. The problem thus treated, however, brings in too many uncertainties, and would be purely of academic interest.

Another disadvantage of the out-of-centre type of rods besides that indicated above is that with equal lengths of auxiliary rods the position of the ignition point varies on the stroke of each cylinder. This note, however, is intended simply to point out the real danger of "out-of-centre" rods when adapted in the case of high-speed engines of 2000 or 2400 revolutions per minute, speeds which are by no means uncommon at the present time. This danger may be so great when the predicted engines of 4000 to 6000 revolutions per minute become practical as to prohibit the use of "out-of-centre rods" altogether.

ENGINEERING ENTERPRISE IN MEXICO.

WERE the Administration of Mexico possessed of a "Reconstruction Ministry," it would find plenty of occupation at the present time. Immense sums must be expended upon the repairs to existing, and the provision of new, engineering enterprises exclusive of the railways, the physical condition of which will demand an outlay of at least £20,000,000 to place them in anything approaching a permanently safe working state. The fact that the Mexican Government is seeking to borrow a sum of £10,000,000 would seem to suggest that something in the reconstruction line is contemplated. Although it is not likely that British investors will be ready to participate in the raising of the loan, it is more than probable that British contractors will be invited, and some may consent to take part in the restoring of the Republic's devastated railroads and in constructing some of the new port works which are projected. The total sum of the estimates for public works at present determined upon is 25,000,000 dol. (gold) (=£5,000,000). Part of this amount, however, if it is raised, is earmarked for further expenditure upon such unremunerative objects as the National Theatre and the Legislative Palace; on the other hand, the much-needed drainage work at Texcico is included. Contracts will also be invited for the construction of telephone lines from the capital (Mexico City) to the States of Puebla and Michoacán.

A large number of water-power enterprises are under consideration, and inasmuch as most of those already established in Mexico have proved very successful, such, for instance, as that in connection with the Mexico City Tramways, it is not improbable that these projects will be proceeded with first. Among the more important are the following: (*a*) The utilisation of the waters in the Rio Metlas, in the State of Vera Cruz, for motive power; (*b*) the use of the Rio Amapa, in the same State, for irrigation and power purposes; (*c*) the use of the waters in the Rio Santa Gertrudis, in the State of Hidalgo, for industrial purposes; (*d*) the impounding of the waters of the Rio Encarnación, in the State of Jalisco, the idea in this case being to build a series of irrigation canals; (*e*) a considerable increase in the water power at present being used by the Michoacán Power Company—an increase of 3000 litres per second, from 7000 to 10,000 litres—and the erection in connection therewith of a large new power-house; and (*f*), the enterprise of a North American engineer, named William R. Ramsdell, who seeks to take water from the Rio Miravalles, in the Municipality of Compastela, to generate 2500 horse-power to operate the mining machinery and mills of the Trinidad, San Francisco, Dulces Nombres, and Tres Estrellas mines.

As regards the more publidc undertakings, there is the construction of the new, and additions to the existing, harbour works at Progréso Port, in Yucatán. Up till now steamers drawing over 10ft. of water have been compelled to anchor at a distance of between four and five miles from the shore. The Federal Government have had surveys made which have resulted in the determination to carry out improvements at a cost of 7,500,000 dol. (gold) = £1,500,000). This sum would include two breakwaters, a channel 600ft. wide to shore, the dredging of the harbour, and the construction of wharves. The existing piers of the harbour are the property of the U. Railways of Yucatán, except the Fiscal Pier, and that is owned by the Government, but leased to the railways for a term of 50 years. Here, also, there will be required several electric winches to take the place of those worked by mule power.

The further deepening of the channel in the Rio Grijalva, in the State of Tabásco, in connection with the port works at Frontéra, is also projected. It is sought by increasing the depth to 28ft. to make the channel available for ocean steamers. The depth of the river up to and 30 miles beyond the town of Frontéra is between 24ft. and 30ft. The approximate cost of the deepening is put at 5,000,000 dol. (Mex.), which would be equal, at the rate of exchange to-day, to £350,000.

EIGHT-COUPLED PASSENGER LOCOMOTIVES.

For operating fast and heavy passenger trains over mountain sections of its road, the Southern Railway of the United States has put in service thirty engines of the 4–8–2 type, to take the place of 4–6–2 engines. These latter engines have cylinders 24in. by 28in., 73in. driving wheels, and 35,000 lb. tractive force, with a total weight of 116 tons and 72 tons on the drivers. In the new engines all the drivers and the rear bogie are equalised in a continuous system. As curves are numerous and sharp, flange oilers are applied to the leading drivers, and the axles have sufficient lateral play to enable the engines readily to pass curves of 280ft. radius. The company has its own design of valve motion, with fixed horizontal link. The boiler has a radial stay fire-box, combustion chamber, brick arch, and superheater. The fire-box door is operated by power. For use in tunnels there is a hinged hood or elbow which can be thrown over the top of the funnel, so that the blast will be directed horizontally backward instead of up against the roof. The dimensions of these notable engines are as follows:—

Cylinders	27in. by 28in.
Driving wheels	5ft. 9in.
Bogie wheels	2ft. 9in.
Trailing wheels	3ft. 6in.
Wheel base, driving	18ft.
Wheel base, total	39ft.
Boiler, diameter	6ft. 6in.
Fire-box	7ft. by 9½ft.
Tubes, No. 183, length	21ft.
Heating surface, fire-box	222 square feet.
" " tubes	3339 square feet.
" " combustion chamber	77 square feet.
" " arch tubes	30 square feet.
" " total	3668 square feet.
Grate surface	67 square feet.
Boiler pressure	190 lb.
Superheating surface	942 square feet.
Weight on drivers	105 tons.
Weight of engine	157 tons.
Weight of engine and tender	240 tons.
Coal on tender	12 tons.
Water in tender	9000 gallons.
Wheel base of engine and tender	73ft. 3in.

THE INFLAMMABILITY OF MIXTURES OF GASES AND AIR.

The United States Bureau of Mines publishes a series of technical papers dealing with important subjects. No. 150 of the series, which has been recently issued, consists of a report made by Messrs. George A. Burrell and Alfred W. Gauger, on the "Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air." The general investigation was undertaken by the Bureau of Mines in connection with its activities to increase safety in mining and the allied mineral industries, and the report summarises the results of very numerous experiments.

The matter is of such interest that we feel sure that a lengthy abstract from the report will be of service to our readers.

The gases investigated were petrol—or, as it is called in the Report, gasoline—vapour, ethane, methane, natural gas, acetylene, artificial illuminating gas, hydrogen, carbon monoxide, and blast-furnace gas. The leading results of the experiments are set out in Fig. 1.

Flame is said to be self-propagated through a mixture of combustible gas and air, or of combustible gas and oxygen, when enough of the combustible gas is present to permit combustion to spread through the mixture from any given point of ignition. Then propagation of flame takes place from layer to layer of the mixture without the continued presence of the source of heat that started the inflammation. The conditions of experiment affect to some degree the limits of complete propagation. For instance, with mixtures of gasoline vapour and air, the low limit was 1.5 per cent. when a mixture of vapour and air was ignited from the bottom upward, and 2.0 per cent. when ignition was made from the top downward. With methane, the limit was 5.50 per cent. for horizontal propagation of flame and about 5 per cent. when ignition was made from the bottom upward. In coal mines, where methane is found, the limits for horizontal propagation are the most important. In general, the limits are slightly lower when ignition occurs from the bottom upward than when it occurs from the top downward.

In some of the experiments a glass vessel having a capacity of 2800 c.c. was used as the container for the gases and of combustible gases in proportions above the upper limit. The upper limit for complete propagation of flame in mixtures of methane and air is 14.5 per cent. But even with a proportion of methane as high as 20 per cent., an electric flash about ¼in. long caused a slight burning, the flame extending about 3in. above the electric flash. The explosion chamber used was 6in. wide and 12in. high. The igniter was placed in the centre.

As oxygen is being used in increasing quantities for industrial purposes, the limits of inflammability of mixtures of combustible gases with oxygen are of immediate interest. As regards methane-oxygen mixtures it was found that the low limit was raised about 0.25 per cent. when pure oxygen was used instead of air. The high limit was, however, extended from 14.5 to 45 per cent. methane, the explanation given by the authors being as follows: In a methane-air mixture containing 9.47 per cent. of methane and 90.53 per cent. of air there is enough oxygen for complete combustion of the methane to carbon dioxide and water vapour. But if more methane be present, carbon monoxide and hydrogen, products of incomplete combustion, result. This reaction takes oxygen that would otherwise form carbon dioxide and water vapour. Some heat is produced, but much more heat is produced in the formation of carbon dioxide and water. As the percentage of methane is increased above 9.47 per cent., more and more carbon monoxide and hydrogen are formed from combustion until so much is formed that not enough heat is produced by ignition of the gas molecules adjacent to the igniter to cause the mixture to propagate flame. As air is only about one-fifth oxygen, substituting oxygen for an equal volume of air greatly increases the proportion of oxygen available for burning the combustible gas, the gas burns to water vapour and carbon dioxide, the heat of combustion is greater, and the upper limit of propagation becomes higher.

Presumably, it is added, the upper limits for other gases would be extended if oxygen were used instead of air. However, the low limits are the important ones as regards danger of accidental explosions, and these are seemingly not much affected.

The values for explosive limits given in the report refer to mixtures of the combustible gases with nearly pure air having a normal oxygen content. However, the oxygen content has to fall considerably before the limits of complete inflammability are appreciably changed. For instance, for mixtures of methane and air the low limit is given as 5.5 per cent. of methane, which is the limit when the oxygen content varies between 17 and 21 per cent. With 17 per cent. of oxygen in the mixture, the limit is raised to 5.7 per cent. of methane. The oxygen content has to fall below 14 per cent. to prevent all explosions in mixtures of methane and air. Replacing the nitrogen of the air with 20 per cent. carbon dioxide raises the limit to 6.4 per cent. methane. Raising the pressure of a gas mixture above atmospheric has no appreciable effect in changing the explosive range.

The authors compressed mixtures of hydrogen and oxygen in a steel bomb to 100 atmospheres before ignition, and found that the explosive range was only a trifle different from the range at an atmospheric pressure. The low limit was raised about 1 per cent.

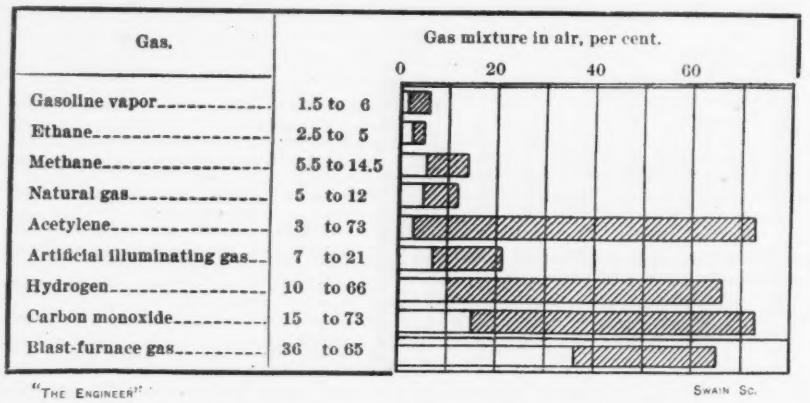


Fig. 1—RESULTS OF EXPERIMENTS ON THE EXPLOSION OF GASES AND AIR

tested. Two copper wires entered through the sides and met at the centre of the vessel. A current of 5 ampères at 15 volts was passed through the wires. Ignition of the gaseous mixtures was brought about by drawing the two wires apart while the electric current was flowing, thereby producing an electric flash.

In all of the authors' experiments the explosion chamber was large enough for its cold walls not to exert appreciable effect on the results. In spite of the slightly different results one can obtain under different conditions of experimenting, the authors express their belief that the values for explosive limits which they give are close enough to be of decided commercial importance. The results were obtained with gas mixtures kept at atmospheric pressure. The authors found that, with mixtures of methane and air, and of petrol vapour and air, raising the initial pressure to six atmospheres had no appreciable effect in changing the limits of complete inflammation, although the explosion, when it came, was of greater violence. As regards the effect of temperatures, raising the initial temperature from ordinary room temperature to as high as 200 deg. Cent. only shifted the low limit for methane from 5.5 to about 5.05 per cent. Presumably, remark the authors, increases of temperature and pressure affect to about the same degree the other gases mentioned in the report.

With a mixture of air and acetylene containing 2.81 per cent. of the latter, inflammation did not spread completely through the mixture. The flame travelled for 1in. or 2in. above the terminals, but did not spread throughout the mixture. With 3.07 per cent. of acetylene, however, the flame spread entirely through the mixture. With mixtures of hydrogen and air no propagation of flame could be noticed by the eye in mixtures containing 7 per cent. of hydrogen when ignition was brought about by means of an electric spark from an induction coil driven by four small dry cells. But when the mixture was analysed after sparking it was found that there had been a slight burning, undoubtedly, only in the immediate neighbourhood of the spark. As further experiments were tried with increasing percentages of hydrogen the amount of hydrogen that burned increased, until with 10 per cent. of that gas it was completely burned.

With mixtures of methane and air, the limits for complete propagation of flame were found to be between 5.5 and 14.5 per cent. With the former mixture the explosion was not violent, and the flame could be easily followed by the eye. With larger percentages of methane—or any other inflammable gas—the explosions became more violent. At the lower limit the flame travels very slowly, compared with its speed in richer mixtures.

Incomplete burning also takes place in mixtures of air

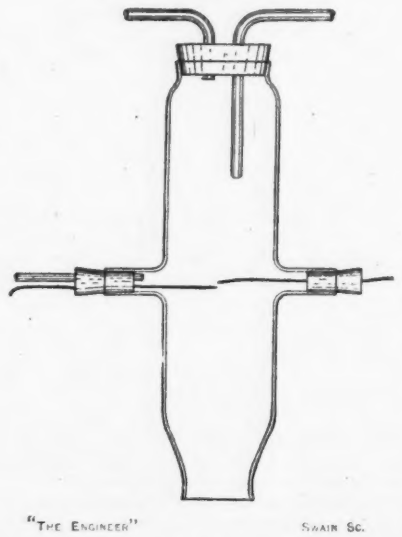


Fig. 2

Explosions have occurred at blast-furnaces owing to the leakage of air into gas conduits, and the subsequent ignition of the resulting mixture. The results of the authors' experiments to determine the explosive limits of mixtures of blast-furnace gas and air are as follows:—

In the experiments a glass vessel of the shape shown in Fig. 2 was used. It was 8½in. long and had a capacity of 900 c.c. A little above the centre two copper electrodes were so arranged that they could be separated by the operator to produce an arc. The top was capped with heavy waxed paper. All the experiments were made with the mixtures saturated with water vapour at room temperature and atmospheric pressure. The blast-furnace gas used had the following composition:—

	Per cent.
Carbon dioxide	10.0
Oxygen	0.5
Hydrogen	2.7
Carbon monoxide	27.5
Methane	0.3
Nitrogen	59.0
	100.0

The results of the experiments are set out in the following table:—

Results of Experiments to Determine the Explosive Limits of Mixtures of Blast-furnace Gas and Air.

Test No.	Percentage of blast-furnace gas in gas air mixtures.	Remarks.
1	20.0	No ignition.
2	30.0	"
3	39.2	"
4	44.8	"
5	50.0	Ignited at once. Blue flame travelled upward and downward.
6	46.5	Ignited at once and blew cap off.
7	45.7	" " "
8	44.9	Small tongue of flame started at arc and rolled to top. No complete inflammation.
9	56.1	Ignited at once and blew off cap.
10	57.0	Cap blown off.
11	61.0	"
12	62.0	"
13	72.0	No ignition
14	67.9	"
15	65.0	Slight snapping ignition around arc. No complete inflammation.
16	64.5	Ignited at once and flame filled bottle.
17	66.0	No ignition.

The proportions of blast-furnace gas that mark the limits of inflammability of mixtures of air and blast-furnace gas of the composition given are 44.9 to 45.7 per cent. for the low limit gas, and 64.5 to 65 per cent. for the high limit. Thus, in order to have an explosion of blast-furnace gas, not less than 35 cubic feet, nor more than 55 cubic feet of air must be present in 100 cubic feet of mixture.

The composition of iron blast-furnace gas, however, varies considerably in practice. The table given below is taken from *Metallurgical and Chemical Engineering*, vol. 10, 1912, page 713, and was compiled from 860 different tests, covering a range of more than twenty furnace linings.

Table Showing Character of Gases Produced in Blast-furnace Using Natural Air with the Corresponding Coke Consumptions.

Coke used, per ton of metal.	Product.	CO_2.	CO.	H_2.	N_2.
Pounds.		Per cent.	Per cent.	Per cent.	Per cent.
3,200–3,400	Spiegel	6.2	30.9	2.3	60.6
3,400–3,500	do	7.0	30.0	3.5	59.5
4,800	Ferro-silicon	3.5	32.5	2.0	62.0
5,300–5,400	Ferro-manganese	4.6	32.6	1.2	61.6
5,400–5,500	"	3.6	32.2	2.2	62.0
5,500–5,600	"	5.0	28.0	2.6	64.4
5,700	"	3.4	33.8	2.4	60.4
5,800	"	4.3	33.1	1.7	60.7
5,900	"	3.8	32.9	2.4	60.7
6,000	"	5.0	34.4	2.7	57.9
6,100	"	3.0	31.2	2.0	61.8
6,500	"	4.4	30.8	2.2	62.6
7,503	"	3.6	32.4	2.4	61.6
2,100–2,200	Bessemer iron	13.1	24.1	1.7	61.1
2,200–2,300	"	12.1	23.9	2.0	61.9
2,300–2,350	"	11.8	25.6	2.1	60.5
2,350–2,400	"	11.8	24.8	1.9	61.4
2,400–2,450	"	11.7	25.4	1.4	61.5

Stoughton gives the average composition for iron blast-furnace gas as about 61 per cent. nitrogen, 10 to 17 per cent. carbon dioxide, and 22 to 27 per cent. carbon monoxide.

Commenting on the figures given in the table, the authors remark that the maximum variations in the composition of blast-furnace gas are apparently in the percentages of carbon dioxide and carbon monoxide. If 45.5 per cent. of gas be taken as the lower limit of the gas, then the limit mixture contained 12.5 per cent. carbon monoxide, 1.2 per cent. hydrogen, and 11.6 per cent. oxygen. Should the carbon monoxide content drop to 22 per cent. and the carbon dioxide content increase to 17 per cent., the hydrogen and nitrogen contents remaining approximately the same as before, then 56.8 per cent. gas will be required before 12.5 per cent. carbon monoxide will be present. If the percentage of carbon monoxide should increase then the lower limit of such a gas would be lower than 45.5 per cent. The maximum per cent. of carbon monoxide in the table is 34.4 per cent. Of this gas 36.3 per cent. would furnish 12.5 per cent. carbon monoxide. The upper limit, however, would not be changed appreciably, as it depends on the percentage of oxygen present, which in turn depends on the percentage of air. For pure carbon monoxide the high limit is only 73 per cent., for pure hydrogen 66 per cent. The lower limit for blast-furnace gas in general, therefore, varies with the amount of combustibles present in the gas from 36 to 37 per cent. gas. The upper limit will, however, be approximately 65 per cent. gas for all gases.

The Public Utilities Commission of New Jersey has issued a statement replying to a complaint that the railroads have been unreasonable in their curtailment of passenger train service. The Commission says that most of the complaints have been based on unwillingness to bear inconvenience which is not great. The statement justifies the railroads in diminishing passenger service in order to provide additional facilities for moving the increased freight traffic.

RAILWAY ACCIDENTS IN 1916.

In the opening sentences of the report to the Board of Trade upon the accidents that occurred on the railways of the United Kingdom during the year 1916, it is observed that in view of the necessity for economy in printing and paper the general report has been amalgamated with the returns of accidents and casualties, and both have been considerably curtailed. This is as was to be expected. Last year the accident reports appeared in half-yearly editions instead of quarterly. Since the Blue-book for the quarter ended September 30th, 1915, there has been no summary of the accidents and casualties during the period covered by the Blue-book, and since the quarter ended June 30th, 1915, there have been no reports of the assistant and sub-inspecting officers as to accidents to men. The main points are, however, dealt with in the report just issued; certain comparative statements are omitted, but to those who are in possession of previous reports this is not any difficulty.

As regards accidents to passenger trains it should be observed that the year 1916 has the advantage, when comparisons are being made, to have had, as its immediate predecessor, the year in which the unfortunate Quintinshill disaster, in which 224 passengers were killed and 242 injured, occurred. We have therefore also added the figures for 1914, and the average for each of the ten-year period 1905–1914. This, it seems to us, is desirable in order that pre-war conditions should be known.

In train accidents there were three passengers killed and 350 injured during the year 1916, which compares with 269 killed and 1432 injured in 1915, six killed and 322 injured in 1914, and with an average of 21 killed and 554 injured for each of the ten years 1905–1914. In train accidents also 12 servants were killed and 182 injured in 1916, as against nine killed and 183 injured in 1915, eight killed and 115 injured in 1914, and an average of nine killed and 142 injured each year during the ten years 1905–1914. But for the Kiltimagh accident the number killed last year would have been seven instead of 12. During 1916 one "other person" was killed and 17 "other persons" were injured in train accidents.

By the movement of trains and vehicles other than train accidents 147 passengers were killed and 1195 were injured, as compared with 162 killed and 2355 injured in 1915, 110 killed and 2224 injured in 1914, and an average of 101 killed and 2140 injured each year of the ten years 1905–1914. Of the casualties during 1916 there were 41 killed and 898 injured by falling when entering or leaving trains, as compared with 46 killed and 1271 injured in 1915, and 27 killed and 1047 injured in 1914. There were 16 killed and 11 injured in 1916 by falling off platforms and being struck or run over by trains, as compared with 17 killed and 18 injured during 1915 and 14 killed and 14 injured in 1914. There were 13 killed and 11 injured in 1916 whilst crossing the lines at stations, as against 17 killed and 15 injured in 1915, and 21 killed and three injured in 1914. By falling out of the carriages during the running of trains 52 were killed and 64 injured in 1916, as compared with 51 killed and 81 injured in 1915, and 37 killed and 75 injured in 1914. By other accidents caused by the movement of trains and vehicles, but not train accidents, there were 25 killed and 211 injured in 1916, 31 killed and 312 injured in 1915, and 20 killed and 296 injured in 1914.

As the cases of passengers injured by being caught by the closing of carriage doors are not shown in the present return, the decrease of 1160 in the number of passengers injured is partly accounted for, seeing that 654 were so injured in 1915. There is also a decrease of 373 in the number injured by falling when entering or alighting from trains. It is possible that this latter decrease is more apparent than real, and may be in part due to the companies being too busy to report the accidents. The number killed by falling out of carriages during the running of trains is much higher than in peace time, and may be described as due to more night travelling by soldiers and sailors.

In what are described as accidents in which the movement of trains, &c., was not concerned, such as passengers falling when ascending or descending steps or falling over luggage or off the platform on to the ballast, the Board of Trade has excused the companies from reporting the non-fatal cases. Of the fatal accidents there were nine in 1916, six in 1915, and nine in 1914. Of the nine killed in 1916 five were due to passengers falling on steps or from platforms.

Coming now to the accidents to servants caused by the movement of trains or vehicles, but not in train accidents, we find that 402 servants were killed and 3519 injured during 1916, 403 killed and 4962 injured in 1915, 417 killed and 4750 injured in 1914, and an average of 388 killed and 4883 injured each year of the ten years 1905–1914. Of those in 1916 there were 11 killed and 312 injured while coupling or uncoupling vehicles, as compared with 10 killed and 584 injured in 1915; 87 were killed and 1639 injured by other accidents in shunting operations, as compared with 96 killed and 2167 injured in 1915; seven were killed and 184 injured by falling from trains or when getting on or off trains or railway vehicles, as against 14 killed and 229 injured in 1915; 76 were killed and 98 injured while working on the permanent way, as compared with 80 killed and 113 injured in 1915; 149 were killed and 257 injured by being caught by trains or vehicles while walking, crossing or standing on the line, as against 129 killed and 279 injured in 1915; and by other accidents 66 were killed and 1203 injured, as compared with 69 killed and 1565 injured in 1915. There were six servants of contractors killed and 16 injured; as against five killed and 25 injured in 1915.

In non-movement accidents the companies were exempted by the Board of Trade from reporting non-fatal cases. Of the fatal accidents there were 39 in 1916, as compared with 59 in 1915, 52 in 1914, and an average of 42 for each year for the ten years 1905–1914. Of the 1916 fatal accidents nine happened whilst dealing with the loading, unloading and movement of goods, as against 12 in 1915; eight servants were killed whilst attending to engines at rest, as compared with four in 1915; 13 by falls on railway premises, as against nine in 1915; four while working on the permanent way, as against five in 1915, and two from other causes, as compared with 26 in 1915. Three servants of contractors were killed in 1916.

In addition to passengers and railway servants members of the general public meet with accidents on the railway. These are classed as "other persons." During 1916 there were 427 "other persons" killed and 326 injured, as compared with 521 killed and 334 injured in 1915, 565 killed and 344 injured in 1914, and an average of 558 killed and 308 injured each year for the ten years 1905–1914. The decrease during the last two years is believed to be due to fewer suicides.

The inspecting officers inquired into 12 accidents during 1916, as compared with 20 inquiries in 1915. The assistant inspecting and sub-inspecting officers held 504 inquiries into accidents to servants, as against 609 inquiries in 1915, and 702 in 1914. These figures are not fairly comparable, as the Board of Trade has, owing to the strain under which the companies have been working, only held inquiries into the most serious cases.

The number of failures of equipment and track are not given, but the following is the return as to accidents to trains. We have added thereto the corresponding figures for 1915, 1914, and 1913.

Nature of accident.	1916.	1915.	1914.	1913.
1. Collisions between passenger trains or parts of passenger trains	34	34	55	54
2. Collisions between passenger trains and goods or mineral trains or light engines	54	100	58	55
3. Collisions between goods trains or parts of goods trains, light engines, or other moving vehicles	151	142	108	116
4. Collisions between trains and vehicles standing foul of the line	7	8	10	11
5. Collisions between trains and buffer-stops or vehicles standing against buffer-stops:—				
(a) From trains running into stations or sidings at too high a speed	14	9	12	9
(b) From other causes	19	35	31	25
6. Trains coming in contact with projections from other trains or vehicles on parallel lines	6	7	9	7
7. Derailments of passenger trains or parts of passenger trains	65	85	81	73
8. Derailments of goods trains or parts of goods trains, light engines, &c.	221	333	282	215
9. Trains running through gates at level-crossings or into other obstacles	221	305	391	350
10. Fires in trains	139	206	188	152
11. Fires at stations or involving injury to bridges or viaducts	30	42	42	24

INDUSTRY AND THE WHITLEY REPORT.

It is satisfactory to note that the interim report on Joint Standing Industrial Councils, generally known as the Whitley Report, issued by the sub-committee of the Reconstruction Committee, to which the question of relations between employers and employed has been referred, is receiving the serious consideration of some of the great trade organisations. It is too early yet to predict whether the suggestions made in the report may lead to the adoption of a definite scheme on the lines suggested for securing a permanent improvement in the relations between employers and employed, but there is general agreement that an essential condition of removing the old spirit of antagonism is that there shall be adequate organisation on the part of both employers and workpeople. What the Whitley Report suggests is the formation of Joint Standing Councils and local and works organisations to supplement and make more effective the work of the central bodies. The objects sought are, among others, the better utilisation of the practical knowledge and experience of the workers, means for securing to them a greater share in the framing of the conditions of work, and the settlement of the general principles governing their part in industry, security of earnings and employment, and the creation of machinery with a view both to the prevention of differences as well as to their better adjustment when they arise. These are the main ideas underlying the scheme put forward, but it is clear that there is a vast field for usefulness in other directions if the organisation which it is proposed to create is of the right type, and commands the confidence of both the employers and employed. It is recognised that this plan is applicable rather to industries in which there are already representative associations of both the capital and labour elements, and that the case of less well organised trades must be treated somewhat differently as regards details, although on the same general plan, and in this connection the Whitley Committee will, in the near future, put forward some practical recommendations. While the committee has refrained from developing its scheme in anything more than skeleton form in the interim report, it lays stress upon a belief, which is shared by many other people, that a permanent improvement in the relations between the two classes in industry must be founded upon something other than a mere cash basis.

The reception given to the report has been on the whole favourable, but to a certain extent non-committal. The Federation of British Industries, which may claim to be the strongest of the new organisations which have come into existence to meet the special needs of the times, has had the Whitley Report under consideration, and has put forward its own scheme for a system of industrial councils, such as the report advocates. The statement embodying this scheme, which has just been circulated, calls attention to one point made in the sub-committee's report with which most of those associated with industry will concur. There is apparently no idea of any active Government intervention in the creation of the proposed organisation, the intention being that each trade shall be free to build up its own organisation voluntarily, and on lines best suited to its peculiar needs. It is laid down that the general principle underlying the suggested councils should be centralisation of policy and decentralisation of administration. The basis of the scheme, as put forward by the Federation, is that of trade councils of masters and men drawn from Employers' Federation and Trade Unions. Such a body, representing all industries, would form the National Industrial Council. Ranking below this would be the Councils of particular industries formed in the same manner, while a third body, to be known as the Trade Councils, would consist of representatives of Employers' Associations and the Trade Unions concerned with a particular trade or section of an industry, while Works Committees, comprised of an elected body of workpeople in each works, would also be called into existence. The functions of these Committees and Councils are briefly set out in the circular which has been issued. The Works Committees would report to or receive from the management complaints regarding any breaches of agreements between employers and workpeople. The Trade Councils would be the first Court of Appeal in case of dispute, and would have the sole power of dealing with agreements and other matters in connection with the particular trade or section, and with any special method delegated to them by the bodies above them. The Councils of the different industries would deal with matters referred to them by the National Council, would initiate consideration of matters of general interest to the industry they represent, and would decide on points to be submitted to the National Council. The latter would be the final Court of Appeal in cases of dispute, and would deal generally with subjects of interest to all industries, and with it would rest the ultimate decision in all matters of general policy, after ample opportunity had been given for discussion and criticism by the other Councils.

A memorandum on the points raised in the interim report has also been issued by the Employers' Parliamentary Council, and some of the criticisms made on that report are worth noting. It is pointed out that the assumption of the Whitley Committee, that the Labour Unions represent the majority of the workpeople, is at variance with the facts, as the Unions represent only a minority of the workers. Comment is made also on the privileged position of Trade Unions under the Trade Disputes Act, the repeal of which it is held is a condition precedent to the establishment of that close co-operation between employers and employed which has now become more than ever vitally essential to industrial prosperity. The memorandum also expresses doubt if any industry is at present completely and perfectly organised, and whether it is possible to bring within the scheme those industries in which no organisation exists. Another matter dealt with relates to the steps which should be taken to render agreements reached by the Industrial Councils binding, and the belief is expressed that only the power to recover penalties from funds reserved to meet liabilities involved would give the necessary guarantee. It is regarded as certain that this aspect of the matter will arise immediately the Councils are set to work. On the question of the restoration of Trade Union rules and customs, which have been suspended for the purposes of war manufacturing, the Committee insists that the definite co-operation and acquiescence by both employers and employed must be a condition of any setting aside of these guarantees. There are, it is believed, many indications that the lessons of the war have convinced even trade unionists that the old rules and customs can never be restored. If the changes necessary can be made a matter of mutual agreement between Employers' Associations and the Labour Unions the outlook for British industry will be full of hope and promise.

The Parliamentary Committee adds that certain of the recommendations made in the Whitley Report are not only practicable, but have for long been in operation in several industries. Viewed as a whole the report is regarded as serving the useful purpose of presenting the problem of industrial reconstruction on definite lines.

IRRIGATION PROJECTS IN SOUTH AFRICA.

Some interesting particulars concerning irrigation projects in South Africa are given in the issue of the *Board of Trade Journal* for August 9th. These particulars have been derived from a report which deals not only with works now in course of construction, but also with proposed new works, the cost of which is to be defrayed by the Union Government, or by Government loans granted to Irrigation Boards. It appears that the Loan Estimates for the year ending March 31st, 1918, provide for the sum of £535,500 being expended on these works; of this amount £362,500 is to be spent on works now in hand, and £173,000 is allocated to new schemes. The sum of £163,000 is to be devoted to the following Government irrigation works now under construction:—The Klipdrift irrigation scheme and the Hartebeestpoort scheme, both in the Transvaal Province; and the Olifants River (Van Rhynsdorp) scheme in the Cape Province; further instalments, to the amount of £199,500, of loans already granted to Irrigation Boards are to be made towards works now in progress.

With reference to the new schemes proposed, £25,000 is to be devoted to the Government irrigation scheme at the Orange River Islands, as a first instalment of an approximate cost of from £150,000 to £200,000 for the first section of the work. This scheme, however, is capable of being carried much further than the present estimate provides for. The complete project would cost approximately £750,000.

New loans to Irrigation Boards will absorb £148,000: The following are the works projected under this heading.

	Total cost. £
Kamanassie storage project (Oudtshoorn)	360,000
Sundays River project (Uitenhage)	250,000
Middleton irrigation scheme (Somerset East)	40,000
Kaffir River irrigation scheme (Bloemfontein)	50,000
New loans to farmers and minor Irrigation Boards	120,000

During 1917-18 the sum of £85,000 is to be allocated to the first four projects, and £63,000 to the last-named. The Kamanassie scheme provides for the construction of water conservation works for the district of Oudtshoorn. This district has suffered severely from drought in late years, and also from heavy floods, which caused great damage to lands, and the present irrigation works are inadequate. A site for the dam has been selected on the Kamanassie River. The length of the dam will be 1265ft., and on the right flank a waste weir will be constructed, 550ft. in length, at 150ft. above datum. It is probable that concrete will be the material chiefly used, and in view of the present very high cost of timber it is considered advisable to build the exposed surfaces in masonry or concrete blocks. The plans include the construction of a high level canal, from the dam, for irrigation purposes.

The Sundays River project is for the erection of a storage reservoir. The site, which has been selected on the Sundays River, will, owing to its width, necessitate the construction of a dam of more than 1200ft. crest length. The question of silting is an important one in this project,

as the flood waters are heavily charged with silt, and much heavy sand is also brought down. It is expected, however, that the use of sluices will minimise the trouble.

The report in question, which contains maps and diagrams of the various irrigation projects, may, we understand, be consulted at the Board of Trade Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2.

THE DEVELOPMENT OF MACHINERY IN THE UNITED STATES NAVY DURING THE PAST TEN YEARS.*

By Captain C. W. DYSON, U.S.N. Navy, Member.

Introduction.

When I assumed duty as first assistant in the Design Division of the Bureau of Steam Engineering of the U.S. Navy Department in July, 1906, I little realised that I was being put in a position where opportunity would be offered me to participate in the greatest advances in marine propulsion that the history of marine engineering has ever known.

During the period covered by this paper we have seen the marine reciprocating engine reach its highest point of development only to be superseded by the steam turbine, which, as in the case of the older engine, was directly connected to the propeller shaft. The direct-connected turbine has had only a short life, and at the present time is rapidly disappearing from the marine stage, its place being usurped by the mechanical and the electric reduction drives.

Coincident with these changes in the types of steam engines for propelling machinery has occurred the development of the internal-combustion engine as illustrated by that most important of the type, the Diesel engine.

Accompanying the advance in main propelling engines were improvements in boilers, in air, circulating and feed pumps; in forced-draught blowers; the adoption of oil for fuel in place of coal, and the development of a method for the more accurate design of propellers for the conditions under which they were to operate.

It is my intention to take you through the marine engineering history of these past ten years as I have seen it, in order to give you in the limited time at my command as clear an understanding as possible of what has been done and of why it was done.

Conditions in 1906.

Upon assuming my duties in the Bureau of Steam Engineering, of the various vessels under construction there were only five whose machinery plants have had any influence upon design during the period of development of subsequent years. These five vessels were; Battleships—Michigan and South Carolina. Scouts—Birmingham, Chester and Salem.

The two battleships, aside from their interest as the forerunners of the Dreadnought and Super-dreadnought classes of vessel, were of interest from an engineering point of view on account of having the first examples of perfected reciprocating engines for main propelling engines and on account of being the first vessels in the navy to be originally built with superheaters applied to the boilers.

The scouts were particularly interesting, as two of them carried the first installations of turbine-propelling machinery that existed in our navy, the Chester being fitted with a four-shaft arrangement of Parsons reaction turbines, while the Salem had a two-shaft arrangement of what is known as the Curtis velocity-compound impulse turbines. The third vessel, the Birmingham, was fitted with high-speed reciprocating engines in order to give a thorough comparison of the three systems.

Valuable lessons were taught us by both battleships and scouts. These lessons were as follows:—

Lessons Learned from Michigan and South Carolina.

Engines.—The engines of these ships were fitted with piston valves of such length that the steam ports were perfectly straight and entered the steam cylinders in the plane of the diameter. This change from the old system, in which the valves were short and the steam passages long and crooked, permitted the use of ports of larger cross-sectional area, resulting in a decrease in steam velocity through the ports, with consequent reduction in steam-pressure drop between the valve chest and cylinder, while at the same time a very considerable reduction in the volume of the ports, and, consequently, in the total clearance volumes was realised. The clearance percentages of the old type of engine, referred to the volumes swept by the different steam pistons averaged about—

	Per cent.
H.P. cylinder	22½
I.P. cylinder	18½
L.P. cylinders	16

With these first engines of the new type these clearances were reduced to

H.P. cylinder	12½
I.P. cylinder	12
L.P. cylinders	11.8

Again, in the old type of engines, the cylinder ratios, neglecting clearances, were

$\frac{\text{I.P}}{\text{H.P.}}$	2.66	say 2¾
$\frac{\text{L.P.}}{\text{I.P}}$	2.65	say 2¾
$\frac{\text{L.P.}}{\text{H.P.}}$	7.046	say 7

These ratios gave an expansion of the steam of about 9, and while such ratios of cylinders tend to light weight, they also produce low economy at full power on account of the low ratio of expansion.

In order to increase the economy of the engines, the cylinder ratios of the Michigan and South Carolina were made

$\frac{\text{I.P.}}{\text{H.P.}}$	2.64	say 2¾
$\frac{\text{L.P.}}{\text{I.P.}}$	3.83	say 3¾
$\frac{\text{L.P.}}{\text{H.P.}}$	10.13	say 10

* From the *Journal* of the American Society of Naval Engineers.

This change in ratios increased the expansion of the steam to about 12, and reduced the mean effective pressure as referred to the low-pressure cylinder from about 55 lb. to 35 lb. per square inch of low-pressure piston area.

As previously stated, the boilers of these vessels were fitted with superheaters. The original estimate of the amount of superheat which could be realised from the amount of surface provided was about 100 deg. Fah., but on trial the superheat at the high-pressure valve chest only reached 86 deg. As the percentage gain in economy by the use of superheat is roughly estimated at 1 per cent. for every 10 deg., the superheat gave a gain of 8.6 per cent. in economy.

The actual gain in economy of the engines of these vessels was, however, considerably in excess of this, although the exact amount is not known, the water consumption of the engines not having been measured. The fuel measurements, however, showed a coal consumption of 1.46 lb. per hour per horse-power of all machinery in operation, which, when compared with 1.775 lb., that of the New Hampshire, one of the last of the vessels having the old type of engine and no superheat, indicates a total gain of 21½ per cent. The difference between 21.5 and 8.6, 12.9 per cent., is a rough measure of the gain due to the changes in the engine proportions and design. This gain will later be shown to have actually occurred, as in later engines the water consumption was actually measured.

Other Points of Interest.

In laying out the main steam piping of the Michigan an attempt was made to eliminate all slip joints by the use of generous bends in the pipes and thus rid ourselves of the trouble due to leaks from such joints. The results obtained were very unsatisfactory, as steel piping of the diameters used, 7in. to 12in., was too stiff to expand freely with the amount of bend that could be installed. It was found impossible to keep the flange joints tight, and the entire system had to be replaced by piping fitted with slip joints.

A departure in the material for the main feed system was also made. In previous ships the feed piping had been of seamless-drawn copper throughout. On the Michigan all feed piping of 5in. diameter and over was made of seamless-drawn steel.

Forced-draught Blowers.—In regard to these, the two battleships also marked the beginning of an epoch; while preceding vessels had all been fitted with blowers of large diameter and slow speed of revolution, driven by reciprocating engines, on these new ships blowers of a type known as the Sirocco were installed, and these were driven by electric motors obtaining their current from the ship's electric plant. While the old-type fans were run at only about 225 revolutions, the new type ran at about 650, resulting in much smaller, lighter machines, and by the replacement of the reciprocating engines by electric motors, vastly increasing the durability and the reliability of the system.

The Scouts.

These vessels, Birmingham, Chester, and Salem, are chiefly interesting as marking the definite abandonment of the reciprocating engine for light, high-speed work and the adoption of the turbine in its place, the reciprocating engines of the Birmingham having been fitted for the purpose of obtaining a comparison of the economy and reliability of the two types of machinery.

The engines of the Birmingham ran at 200 revolutions, those of the Salem, which vessel was fitted with Curtis turbines, at 350 revolutions, and those of the Chester at 502 revolutions, the engines developing 16,000 indicated horse-power for the Birmingham, and 16,000 shaft horse-power for each of the other two vessels, the steam pressure being 250 lb. per gauge.

While the Chester was the first example of Parsons turbines in our Navy, this type of turbine had been so thoroughly developed in all its details before being pushed forward as a competitor of the steam engine that the installation fitted to the Chester was similar in its arrangements and mechanical details to all subsequent vessels in which this type of turbine was installed. The turbines were arranged on four shafts, with a high-pressure on one and an intermediate cruising turbine on the other of the two inner shafts. While later vessels with four-shaft arrangements were fitted with backing turbines on all shafts, the Chester differed, and backing turbines were fitted to the inner shafts only.

The Chester was a successful ship from the outset, as was the Birmingham, and both vessels reflected credit upon their builders.

The experience with the Salem, however, was far from satisfactory, and the reasons are not difficult to find. In tracing them out it will be well to give a short sketch of the progress of the Curtis turbine up to the date of completion of the Salem.

The Curtis turbine is of the type known as "impulse velocity compounded." It had been used quite extensively on shore for driving electric generators before the marine type was designed. The type used on shore being built as vertical units, it became necessary to depart from this form to adapt the turbine for use on board ship.

At this early date the theory of this turbine carried with it the idea that as all expansion of the steam took place in the steam nozzles, wherein steam pressure was changed into velocity, there was no change in pressure throughout the blades of any one stage, and that therefore there was no unbalanced steam thrust on the rotor of the turbine.

The earliest marine application of the Curtis turbine occurred on the yacht Revolution, in about 1902. These turbines were provided with only two stages, and developed shaft horse-power equivalent to 1800 indicated horse-power at 672 revolutions. A Board of Naval Engineers, reporting on the performance of these turbines in 1903, stated "This plant, being the first large set of steam turbines installed for screw propulsion in the United States, it seems appropriate to mention that the general performance of these turbines, although themselves built rather in the nature of experimental appliances, was quite satisfactory, and they are well adapted as a type of motor for the transmission of propulsive power." * * * "The points in conjecture with regard to these machines being their efficiency and their capacity to compete in economy with the best marine engines, should be ascertained by more accurate tests, both on land and on board ship, where this is possible. The opinion of the undersigned (the Board) is that such tests are warranted, and eventually will result in the application of a motor for screw propulsion highly satisfactory to the naval service."

Following this report the Southern Pacific Steamship Company placed an order with the Fore River Shipbuilding Company for the construction of the s.s. Creole to be fitted with Curtis turbines, and in 1905 the Navy Department contracted with the same company for the construction of the Birmingham and Salem.

The turbines of the Creole and Salem were made practically from the same patterns, the nozzle areas of the Salem being, however, twice as great as those of the Creole on account of being called upon to deliver twice the power. The turbines were built with seven-wheeled stages, the drum type of Curtis turbine not having yet appeared upon the scene.

The turbines of both of these vessels were fitted with a type of blading which "hind sight" has taught us was so weak as to be a serious menace to the reliability. The diaphragms between stages were made each in one piece, and to overhaul the shaft packing of any diaphragm required that the turbine shaft be completely stripped up to and including the desired diaphragm. Further, the thrust bearings were made completely independent of the turbine casings, which was a serious mistake, as these bearings should come and go with the turbine as it expands or contracts. Also, in the case of the Salem, while the turbines of the Creole were made rights and lefts, those of the Salem were made rights only, the port turbine being exactly the same as the starboard, but being turned end for end when installed in the ship. This resulted in adding the unbalanced axial thrust of the turbine to the propeller thrust and unduly overloaded the thrust bearing and its support, and has been a continual source of trouble ever since the vessel went into service.

A comparison of the machinery weights of the three scouts will be interesting, both actual weights and weights per actual power developed on trial.

The total weight of machinery installation, including propelling machinery, auxiliary machinery, piping, boilers, and fittings, smoke pipes and uptakes, lagging and clothing, flooring, ladders and gratings, fittings and gear, stores, tools and spare parts carried on board, and pipes, valves, &c., connected to machinery not under cognisance of the Bureau of Steam Engineering, was

	Dry. Tons.	Wet. Tons.
For Birmingham	760.82	843.97
,, Salem	853.85	908.96
,, Chester	735.87	800.69

The weight per horse-power delivered was

		Pounds.
For Birmingham	(I.H.P.)	117.18
,, Salem	(S.H.P.)	112.68
,, Chester	(S.H.P.)	89.67

Turning now to the question of relative efficiencies of propulsion, and reducing the indicated horse-power of the Birmingham to shaft horse-power by multiplying by .92, the shaft horse-power per knot speed per hour required were as follows:—

Knots.	10	15	20	24	25
Birmingham	92	156	331	563.5	
Salem	97.5	193	380	600	710
Chester	80.?	190	362.5	604	758

These power results are not particularly consistent, due, probably, to the characteristics of the hulls of the vessels and to variations in weather conditions under which the trials were held. There may also have been errors in the torsion-meter readings, especially at the low speeds, where a slight error would produce the greatest percentage error.

Now, the true measure of efficiency of propulsion is not horse-power required for any speed, but is either steam consumption or fuel consumption required to produce the speed. Where oil fuel is used the personal element of the operating force is reduced to a minimum, and measurements of fuel are preferable to measurements of steam consumption, as the first gives a gauge on the efficiency of entire machinery plant, including boilers, while the latter gauges the efficiency of the engines and auxiliary machinery only. Where coal is used as the fuel the personal equation of the fire-room force enters largely into the problem, and therefore, measurements of steam consumption are to be preferred in such cases.

The steam consumptions in pounds per hour of the three vessels, for all purposes, on these trials were as follows:—

Knots	10	15	20	24	24.5
Birmingham	34,000	66,000	134,000	285,500	
Salem	44,000	84,000	150,000	273,000	300,000
Chester	43,200	76,500	138,500	254,800	284,000

The steam consumptions of the main engines, only, at these speeds were

Knots	10	15	20	24	24.5
Birmingham	21,000	50,400	113,000	247,000	
Salem	29,900	66,700	127,300	238,000	261,800
Chester	24,250	56,200	118,000	218,000	244,000

Pounds of water per hour per shaft horse-power (main engines only):

Knots	10	15	20	24	24.5
Birmingham	22.82	21.6	17.06	18.26	
Salem	30.7	23.	16.8	16.50	14.75
Chester	30.3	19.72	16.27	15.03	13.34

Attention is called to the fact that while the total steam consumption with reciprocating engines is decidedly better below about 22 knots than that of either the Curtis or the Parsons turbines, even though the latter are fitted with cruising turbines which are in use from 20 knots down, the economies are about even at 22 knots, and above that speed both types of turbines have a decided superiority. Hence, in cases where high speed and light weight were the prime factors to consider in the design of machinery for a vessel, some type of turbine machinery was always to be preferred over reciprocating engines. In cases where the speed of vessels was comparatively low, where high speed was seldom called for, and where economy of propulsion at cruising speeds was of paramount value, the reciprocating engine was, under the conditions of turbine design existing at this early date, very much to be preferred.

For several years after the adoption of turbines as a prime mover for marine propulsion the turbine designers and builders successfully blinded the public concerning the performances of turbine vessels by comparing the steam per horse-power required by turbines with that required

by reciprocating engines, and, as shown by the comparison of these amounts for the scouts, the argument was a very good one, if the material data necessary to reduce the figures to figures of pounds of water per knot run were not available.

Leaving these vessels we now reach the starting point of what may be called the modern navy.

(*To be continued.*)

THE INTERCONNECTION OF ELECTRICITY SUPPLY SYSTEMS IN LANCASHIRE AND CHESHIRE.

We have been favoured with a copy of the Second Report of the Committee for the Interconnection of the Lancashire and Cheshire Electricity Supply Systems. The Committee, it may be mentioned, was made up as follows :—Chairman, Mr. S. L. Pearce; Vice-Chairman, Mr. B. Welbourn. Members : Sir John A. F. Aspinall, and Messrs. R. Blackmore, S. E. Britton, H. Dickinson, E. H. Edwardes, John Purrett, S. J. Watson, P. P. Wheelwright, and W. J. H. Wood, with Mr. J. A. Robertson as honorary secretary.

The Committee issued an interim report in September, 1916, to the Supply Authorities and the Board of Trade, and it formed the basis of the Conference held in the Council Chamber of the Town Hall, Manchester, on the 2nd March, 1917, which was presided over by Mr. G. H. Roberts, M.P., Parliamentary Secretary to the Board of Trade. That Conference revealed a striking degree of unanimity with the principles set out in the interim report, and as a result of the invitation extended by Mr. Roberts to the Conference, the Committee has worked out the essential details of a scheme, which are embodied in the present report.

The proposal now put forward is that a Joint Board representing the Local Authority and Company interests should be established. The local authorities are to be represented on the Board in proportion to population, and the companies on a basis of capital outlay. Recognising the disadvantages that would accrue from too large an administrative body, the Committee proposes that the Joint Board should be divided into district boards, the members of which should be those representing the undertakings corresponding to certain groups.

Group A is to consist of Eccles, Manchester, Middleton, Salford, Stretford, Swinton, and Pendlebury, and the Trafford Power Company. The combined populations amount to 1,090,000 persons, and the representatives on the Board would total twenty-three. Group B is to be made up of Atherton, Bolton, Bury, Farnworth, Haywood, Hindley, Leigh, Littleboro', Radcliffe, Rochdale, Turton, Wigan, the Lancashire Electric Power Company, and the South Lancashire Tramways Company. The populations are a total of 612,000 and the group would have thirty-three representatives. Group C is to include Ashton, Oldham, Stalybridge, Stockport, and the Glossop Electric Supply Company. In this case the total population affected is 414,000, and there would be fourteen representatives. Finally, group D comprises Accrington, Bacup, Blackburn, Burnley, Colne, Darwen, Haslingden, Nelson, and Rawtenstall, with their populations totalling 463,000. It would have twenty representatives.

Each district board is to elect a chairman from amongst its own members, and the engineer of each undertaking is to be entitled to attend the meetings of the respective district boards.

A central executive of twenty members is to be elected from the district boards on the following basis :—

	Population.	Representatives.
Group A	1,090,000	7
,, B	612,000	5
,, C	414,000	
,, D	463,000	3
The Lancashire Electric Power Co.*	—	2

* This is in addition to this company's representation on District Group B, which may carry with it a seat on the Central Executive.

The Central Executive is to elect a chairman from amongst its own members.

The Powers of the Proposed Joint Board.

It is suggested that the Joint Board should be empowered amongst other things :—

(1) To co-ordinate and prescribe the running hours of the existing generating stations in such a way as to yield the most economical operating conditions.

(2) To determine the basis of charges to be made between the various authorities constituting the Joint Board for bulk supplies, standby supplies and reciprocal supplies.

(3) To allocate all charges against revenue account arising out of the expenditure of monies on linking-up mains, transformers, and such other works as may be required for inter-connecting purposes.

(4) To act in an advisory capacity as regards all proposals for future extensions of generating plant and linking-up mains, transformers, and such other works as may be required for inter-connecting purposes that may be put forward from time to time by one or other of the several authorities direct to the proper Government Tribunal.

(5) To empower the Joint Board to make working arrangements between the power companies and the local authorities, and between one local authority and another, for the use of the existing mains, and with reference to the laying of new linking-up mains within the areas of the several undertakings participating in the joint scheme of operation, and in such other areas as it may be found necessary to lay linking-up mains.

(6) To invest the authorities constituting the Joint Board with compulsory powers to obtain wayleaves for electric mains and overhead lines; to lay mains in undedicated streets; to erect overhead lines crossing public roads; to make regulations regarding all technical matters affecting linking-up mains, transformers, and such other works as may be required for interconnecting purposes in order to secure uniformity and reliability of supply, &c. The authorities constituting the Joint Board are, further, to be empowered to enter into agreements with any authority, company, or person for bulk supplies, standby supplies, or reciprocal supplies. The Committee does not propose to invest the Joint Board with any financial powers to raise capital from time to time. In this respect the present proposals differ from those set forth in the interim report, which contemplated the raising of capital for purely interconnecting works, *e.g.*, linking-up mains and transformers, &c. On further consideration the Committee has come to the conclusion that *under existing conditions* there are no material advantages to be gained in relieving each undertaking of its statutory obligation to raise the necessary capital for interconnecting mains extensions within its own area, provided always that the report is initiated or approved by the Joint Board, the important point being the correct allocation of this expenditure between participating authorities.

The Report then proceeds to discuss the following matters :—"The Basis for Determining the Charges for Electricity Supplies," and "The Basis for Allocating the Capital Charges on Interconnecting mains, Transformers and Switchgear against the Revenue Accounts of the Participating Authorities." It then makes various miscellaneous provisions, among which we notice the following :—"The Committee cannot refrain, however, from giving expression to the opinion that the practice of making profits for the purpose of handing over substantial grants in aid of local rates is detrimental to the interests of an adequate and economical supply of electricity, particularly for industrial purposes." On the other hand, it lays stress on the necessity of making adequate provision for depreciation and obsolescence of plant.

Briefly put, the Committee's principal recommendations on interconnection are as follows :—(*a*) As a preliminary step it is essential that a scheme of interconnecting the power stations of certain of the existing electrical undertakings in Lancashire and Cheshire should be at once proceeded with; (*b*) that the proper authority to control this movement would be a local joint board, on which local authority and company interests are represented in the manner set forth in the foregoing Report; (*c*) that the existing rights of all electrical undertakings as distributors should be observed within their statutory areas; (*d*) any undertaking adversely affected financially by reason of the co-ordination of the interconnected power stations should be re-imbursed by the participating authorities.

The Report also deals with "The Conferment of Additional Powers upon the Joint Board as regards the Establishment and Control of all Future and Existing Power Stations and High-Pressure Transmission Lines;" and "The Relation of the Joint Board to the Existing Government Departments, or to any New Electricity Tribunal that may hereafter be set up;" but does not come to a unanimous decision on these matters.

A MUNITIONS COUNCIL.

It was officially announced by the Ministry of Munitions, on Monday last, that it has been decided to appoint a "Munitions Council," so as to ensure the better and more economical working of the department. The Council consists of the Minister as President, of the two Parliamentary Secretaries as Vice-Presidents, of members each representing a group of the departments of the Ministry, and a secretary.

The groups chosen, and the Members of Council representing them, are as follows :—

Group.	*Member of Council.*
F. Finance.	Sir Herbert Hambling.
D. Design.	Major-General the Hon. F. R. Bingham, C.B.
S. Steel and Iron.	Mr. John Hunter.
M. Materials, &c.	Sir Ernest Moir, Bart.
X. Explosives.	Sir Keith Price.
P. Projectiles, &c.	Sir James Stevenson, Bart.
G. Guns.	Sir Glynn West.
E. Engines.	Sir Arthur Duckham, K.C.B.
A. Allies.	Sir Frederick Black, K.C.B. (Temporarily, Sir Charles Ellis, K.C.B.).
L. Labour.	Sir Stephenson Kent, K.C.B.
S. Secretariat.	

In an explanatory note issued at the same time by the Ministry, it is pointed out that the recent enormous growth of the department has rendered necessary important changes in the system of control, and the appointment of this Council. A year ago, when Mr. Lloyd George gave up office, the headquarter staff numbered 5000. It has now increased to 13,500. The volume of business transacted by the Ministry, and the scale of its operations, have increased at an equal or even greater rate, and the department is now employing some 2,000,000 persons, besides being in contact at innumerable points with almost every business interest in the country, and being responsible for expenditure which "may well amount to between six and seven hundred millions a year."

SUGAR MACHINERY FOR ARGENTINA.

Just before the war broke out an Austrian manufacturer of sugar machinery (the Breitfeld Danek Engineering Company) had succeeded in introducing its machinery into Argentina in direct competition with that of British and French origin. A considerable number of fresh orders were obtained, but none, or very few, of these have been executed. That there is an urgent demand for additional equipment cannot be denied, and the opportunity of supplying it rests with British manufacturers, who already enjoy a high reputation in the Republic for the excellence of their machinery. The most important district in the Argentine for sugar-cane mills is the Province of Tucumán. There, and in the two neighbouring Provinces of Jujuy and Santa Fé, there are over thirty first-class sugar mills, some with a grinding capacity of 2200 tons in 24 hours. The largest mill is that known as Santa Ana, with this capacity. The Santa Rosa, the Santa Pablo, and the Santa Barbara are all of importance. At least one of the mills—La Cruz Alta—is of German ownership, and, no doubt, German influence is strongly felt in connection with the management of others. But, inasmuch as it is impossible now, and may remain difficult for a long time, to obtain any additional equipment from Germany or Austria, it is not expected that any opposition would be offered to the introduction of British-made plant if this could be, by any possibility, secured. Among the French manufacturers whose installations are to be found here are the Cail and Fives-Lille Company. The Krajeuski-type of crusher is in almost universal use, with open defecation, while most of the boilers are of the well-known Babcock and Wilcox type, the minimum pressure being 100 lb. to 110 lb. It is understood that machinery orders to the value of several thousands of pounds sterling are awaiting manufacturers in Argentina to-day. The same applies to all kinds of equipment, apparatus, tools, and general stores of an engineering character.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Busy Mills and Forges.

The mills and forges have now got into full swing again, but consumers are pretty well covered as regards their present requirements in raw material, and some little time must elapse probably before holiday influences disappear. Buyers are still more in evidence than sellers, and such business as is passing is sufficiently indicative of the continued strength of the market. There is widespread testimony to the punctuality and goodwill with which the ironworkers have returned to their employment after the holiday break. On 'Change in Birmingham to-day—Thursday—ironmasters announced that orders had to be refused because there was no sign of execution being guaranteed for some months. Orders are on the books for the rest of the year, and some will run a longer period. Offers to place specifications for deliveries into next year are declined repeatedly, yet fresh inquiries are put forward with the same result. Meanwhile, demands for Government work are increasing, and buyers want the quantities doubled. Export merchants were unable to get any offers considered, and merchants engaged in the home civil trade failed to secure acceptance of orders. Ironmasters reported that they had to devote all the output to work for war requirements, and would not think of booking any other business. The Government "control" may be said to be complete, no order being allowed to pass without the sanction of the Ministry of Munitions. Even merchants report that they sell to war workers fully 80 per cent. of the material passing through their hands. The mills and forges are late in clearing old orders which were accepted last quarter, and other business which has come to hand since will certainly occupy the mills to the end of October and after. Many buyers desire to have the option of extending existing contracts, but generally fail to succeed in persuading makers to fall in with their wishes. The constant pressure on the works to finish specifications renders it difficult to avoid breakages of machinery, and at some works duplicates for prompt renewals are not available. This circumstance naturally causes delays here and there in the getting out of orders.

Manufactured Iron Prices.

Common bar iron changed hands to-day—Thursday—in Birmingham at £14 10s. to £15 10s., according to quantities and the period of supply, delivered, or £13 15s. net at makers' works. Makers of plain black sheets had more inquiries at £19 for galvanising sorts of 24 w.g. Strong working-up sheets were £22, while thin sheets for Government work were quoted £24 and £25. In hoops, business was recorded at £18 10s., and larger parcels were asked for than disposed of. In small rounds, angles, fine strip, and oval iron a good business was realised at recent selling prices. High qualities of nut and bolt iron and similar makes are being sent into the district by Northern houses at £14 11s. 3d. per ton, delivered, and other grades range down to £14 5s. per ton. All the finished ironmakers are in trouble over the deficient supply of puddled bars. It is a noticeable feature of the finished bar trade just now and the prices attached thereto, that so many specifications do not come within the standards laid down for the Government price control that business generally yields a higher return than the £13 15s. net at works for merchant bars, which is the special maximum for this class of iron. No easing of the price tension in the small iron department is observable, but consumers do not complain about this, their difficulty being that they are greatly under-supplied at any price. Practically all the finished iron branches are very busy. The sheet trade is the notable exception to the prevailing activity. Some sheet millowners did not reopen their galvanising departments after the holidays owing to the difficulty of getting steel sheet bars as a raw material and spelter. Current demand for black sheets keeps about one-fifth of the productive capacity employed.

Foundry Pig Iron Trade.

Openings are ready to hand for all the pig iron that is coming on the market. Some producers say they could sell more if they were prepared to entertain all the offers made to them. There is no actual deficit, however, when output and consumptive demand are compared, and exports are on a scale which would admit of any disparity which arose being readily redressed. For some classes of foundry iron demand is easier. The Derbyshire foundries are not working much above half their normal capacity. Hardly anything is being done in the pipe founding trade now. Derbyshire smelters are, accordingly, cultivating the forge iron branch to a greater extent. Here demand runs very strong. In one case Northamptonshire foundry pig is said to have been sold at something like 2s. below the maximum. This appears to be an isolated case, however, due apparently to competition for an outlet which was dictated by special considerations. Sellers generally quote full maximum rates, and appear to be able to get all the business they want on those terms South Staffordshire foundry iron is in as steady request as forge. Maximum pig iron prices continue at :—South Staffordshire common, 95s.; part-mine forge, 100s.; foundry, 102s. 6d.; all-mine forge, 115s.; foundry, 120s.; warm-air forge, 145s.; warm-air foundry, 155s.; and special quality, 167s. 6d., while cold-blast iron is 182s. 6d. North Staffordshire prices are: No. 4 forge, 95s.; foundry numbers,

97s. 6d.; and basic also 97s. 6d. Northamptonshire iron is quoted: No. 4, forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry, 94s.; and basic 97s. 6d. Derbyshire qualities are: No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; No. 2 foundry, 94s. 6d.; No. 1 foundry, 96s. 6d.; and basic, 97s. 6d.

Basic Iron Progress.

Producers of basic iron for the steel makers cannot meet the many calls on them, and orders sent to other districts are being returned. One Staffordshire firm, whose furnaces are idle, is being urged by the Ministry authorities to commence alterations for making basic iron; but in spite of statements to the contrary, it is understood that no decision has been yet arrived at. The outlay of capital has to be considered. In Northamptonshire and Derbyshire, however, the appeal of the Ministry of Munitions is meeting with more success, greatly to the satisfaction of the steel trade. Three Northampton firms at least are either already making basic or hurriedly pressing on preparations for furnace conversions to this material.

More Steel Works Extensions.

Users of steel, apart from the controlled firms, find the greatest difficulty in supplying their needs. Outside consignments, so far as this district is concerned, are confined to American wire rods, which command the extravagant rates lately ruling. In addition to the new steel works contemplated extensions of heavy rolled steel plant at existing works in this district are being discussed in various directions, some of them of a very important character, particulars of which I hope to give in some early future letter. Current buying and selling transactions are mostly for munition work, and the bookings are at the fixed rates of the Ministry. Billets are booked at £11 5s. for defectives, and a great many of the deliveries are for South Wales consumers.

Scrap.

There is an active trade in cast iron scrap. The lighter descriptions fetch £4 12s. 6d. per ton, and heavy £5 5s. per ton.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THERE is very little of immediate interest in the appearance of the iron and steel markets this week, and the meetings of the trade have been neglected to a large extent partly by reason of lassitude, and partly because a good many people are this year indulging in longer holidays. Merchant trade in finished iron and steel is practically held up: for many merchants have decided that business under the regulations does not pay in any case, and the scarcity of such material makes the work of arranging distribution much more costly than in ordinary times. The theory that 2½ per cent. profit on finished iron and steel is a "living wage" is all very well when transactions in hundreds of tons can be put through; but 2½ per cent. on a five-ton lot does not cover the cost of carrying on. If these fixed profits are to be continued for another two years or so, there should be a scale of quantities, say, 2½ per cent. for fifty tons and upwards, and a higher percentage on small lots. The merchant who does not carry stocks would then be able to continue his business whenever there was any material available. The stock-holder is already allowed a margin of profit to cover his special costs, but his difficulty is of another kind. He requires greater freedom in replenishing his stock and keeping up his assortments so as to be able to meet any order received. This question also requires attention if the war is to be continued for another year or two. Experience has taught the trade something as regards the way in which control should be exercised. That it is necessary may be admitted so far as steel is concerned, but the crude methods adopted could now be easily improved. The stock-holder should certainly be relieved from some of the restrictions and encouraged to carry on his business, for it means economy in the production of steel. Direct orders for small lots of varying sections are a great inconvenience, and in some cases a positive loss to steel works where the only really economical method is to produce as much as possible of one section before changing the rolls.

Foundry Iron.

There is a continuance of the larger supply of Cleveland foundry iron, and although better shipments are being made, there is still plenty for home consumption. This position enables Cleveland iron to compete with Derbyshire iron in those districts of Lancashire where the carriage from Derbyshire is higher and that from the North-East lower; and while the supply lasts this form of competition is likely to increase. What effect it may have on prices in Manchester remains to be seen, and this depends a good deal upon what the demand in the South is likely to be. At present one cannot judge very well, because the slackness of demand always associated with August continues. Sellers of Derbyshire and Staffordshire foundry irons are not at present much concerned about this slackness, and no doubt have yet a good many orders on their books to be executed; perhaps sufficient to keep the furnaces occupied for some time. The prices quoted here are unchanged at 98s. 8d., delivered, for Derbyshire, including a merchant's commission, and 102s. 6d. for Staffordshire. As there is very little prospect of alteration consumers have in many cases adopted a hand-to-mouth system of buying, and this system will only receive a check if later on there should be a shortage, or perhaps longer delays in getting deliveries through. This, of course, means a good deal more work for the merchant, and some people are getting a little tired of much work for little pay, for the 1¼ per cent. on pig iron in small lots is not a princely remuneration. The demand for Scotch foundry iron is small, but fairly steady, and business continues at the official prices of 126s. 6d., plus commission, for the lower brands, and 128s. for the higher brands, delivery free by rail to this district.

Finished Material.

There is a considerable demand for finished iron and very great trouble in getting it. Of course, the Government works can obtain Lancashire bars at the official maximum, but it is a very different thing when the order is for private work. As your readers know, the maximum is £13 15s., and to show how artificial it is I need merely mention that a lot of second-hand bars was sold recently by a dealer at £18 per ton. This proves fairly well that although the nominal price of bar iron may be £13 15s., the real value to a consumer must be very much more. Finished steel is not offered here at all, and the prices published are no guide to the actual situation.

Semi-steel.

There are no offers of billets and no further information as to the chances of getting some American semi-steel.

Scrap.

Rumours of inquiries made by Government officials into the position of heavy wrought scrap are frequent, and apparently the books of some of the buyers are being examined, presumably to find out whether or not prices above the official limit have been paid. It is to be hoped that the inquiring officers will return to London with a conviction that if the trade is to be carried on a withdrawal of the official limit is necessary; or if not a large increase in the legal price. When both buyers and sellers combine to arrange prices higher than the official maximum, it is obvious that there is something decidedly wrong with that maximum. It is, of course, a matter of common knowledge that the maximum was fixed in utter ignorance of the state of trade, and this was the verdict passed upon it from the very beginning. Meanwhile, business in heavy wrought scrap is held up. Very little is being done now in heavy steel scrap of the ordinary melting quality For special material such as shell discard bars very high prices are paid by consumers who cannot obtain ordinary bar steel, but the ordinary scrap sells very slowly at 105s. plus a commission. A little was sold at 107s. 6d. net, this week, but the big markets are South Wales and Cleveland, and with them there is little being done. Wales could buy more steel scrap, but the heavy carriage is against the trade, and Cleveland apparently is full up for the present. Steel turnings are in demand, and if it were legal to do so buyers would gladly pay 65s. per ton; but the maximum is still 50s. only. This regulation also wants altering. In foundry scrap a fair business is reported, and dealers are rather firmer than they were. A special parcel was sold lately at 115s. per ton, but the more general prices range from 102s. 6d. to 110s. delivered. Cast iron borings are scarce and at extravagant prices.

Metals.

Strong copper sheets are quoted here at £160 per ton, and English ingot tin at £243. Trade in scrap copper is now avoided by the dealers, and gun-metal has become a little easier owing to the ease in the copper market. Good gun-metal could probably be bought here now at £128 per ton.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a state of very great activity in the hematite pig iron trade, and a large volume of iron is being produced. The whole of this iron is finding a prompt outlet, and still more iron could be disposed of. It has not yet been possible further to increase the output of metal, there being thirty furnaces in blast; but everything is being done to get furnaces ready, and with a fuller supply of raw material, as well as labour, more plant will be put into operation. Local steel makers' requirements continue to be heavy, and most of the iron made at Barrow goes into direct consumption at the neighbouring steel works. The position at Workington is the same. Prices are steady at the maximum rates, with 127s. 6d. per ton f.o.t. for parcels of mixed numbers of Bessemer iron, and special brands are at 140s. per ton. Nothing is being done in warrant iron.

Iron Ore.

There is a very keen demand for hematite iron ore, not only on local, but on general home account. Local consumers, in fact, could take the whole of the tonnage raised. There is still a want of additional labour, but of late more men have been started. Many more are wanted, and accommodation for them has been made. In both Furness and Cumberland developments are being carried out at the mines, and extensions pushed forward.

Steel.

In the steel trade there is a very busy condition of things, both at Barrow and Workington. The demand for semi-manufactured sorts is very heavy, and from the available mills a good output is being maintained. Some of this material is being used up in the district, and a good tonnage is being sent away. For rails the demand is limited, and nothing is being done in ship or boiler-plates at present. The steel foundries are very busy. Prices are unchanged, with heavy rails at £10 17s. 6d. to £11; light rails, £14 to £14 10s.; heavy tram rails, £14; billets, £10 7s. 6d.; ship plates, £11 10s.; boiler-plates, £12 10s. per ton.

Shipbuilding and Engineering.

These trades present no new features. At Vickers' Naval Construction Works, on Barrow Island, some personal changes have been made. With the retirement of Mr. A. Miller, one of the directors, Mr. John Barr, chief accountant, has been appointed a director, and Mr. J. C. Ferguson, deputy head of the commercial department and local secretary. Mr. W. Pritchard has been appointed chief accountant.

Fuel.

The demand for coal is brisk, with good steam sorts at 25s. to 27s. 6d. per ton, and house coal is at 27s. 6d. to 37s. 6d. per ton delivered. Coke is in full demand at 33s. to 35s. 6d. per ton, delivered, for East Coast qualities, and Lancashire coke is at 31s. per ton delivered.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Iron Trade.

BUSINESS on the Cleveland iron market this week has been dull and quiet in consequence of the holidays, but the tone continues very strong. The allotments for the current month are fully adequate to meet requirements, and with iron in good supply the quantities needed have been covered without any difficulty. There is, in fact, no great pressure just now at the home foundries excepting those which are engaged on Admiralty work. Having regard to the present favourable condition of supply it is probable that larger allotments of foundry iron for shipment will be allowed. There is no change in prices, the home maximum for No. 3 g.m.b. Cleveland pig iron, No. 4 foundry, and No. 4 forge being 92s. 6d., with a premium of 4s. for No. 1. Export quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

The hematite position is very stringent, and is likely to become more so with the acceleration of the shipbuilding programme, and much is hoped for from the preparations for the extended manufacture of basic iron from native ores. Meanwhile deliveries are going forward very regularly, and there is no apparent clamour for iron on the part of home consumers. On the export side there is but little development, exporters realising that in present conditions there is but little surplus to spare. The July export allocations are not yet to hand, and it is probable that they will be lumped together with those for August. But a curtailment of the quantities allowed is considered inevitable. Everything possible is being done to facilitate the shipment of iron already licensed. The home maximum price of East Coast mixed numbers is 122s. 6d., and the export quotations remain at the nominal figures of 137s. 6d. for France and 142s. 6d. for Italy.

Iron-making Materials.

In the foreign ore trade the Spanish strikes are not without their effect upon deliveries, but there are well-founded hopes of a speedy settlement of the present troubles. Coke is strong, with good medium furnace kinds at about 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trades have been so completely under the holiday influence this week that business has been practically at a standstill. It is certain, however, that there will be no cessation in activity for many months to come. Order books are overloaded with future business, and a considerable period must necessarily elapse before this is run off, even although no fresh orders are placed in the meantime. The predominating feature in this tremendous activity is, of course, the Government orders, which have practically eliminated ordinary commercial business. To make allowance for the stoppage and keep output at the required level a very strenuous effort was put forth during the days preceding the holidays in all Government controlled establishments, the result of which was eminently satisfactory. Practically all the works are closed for a full week. That a break so prolonged is possible is clear evidence of the wonderfully improved position now occupied generally by the Allies with regard to supplies of munitions, whilst at the same time the holiday is designed as the Government's testimony to the splendid work accomplished by the workers. Considerable attention is being paid to the overhauling of plant and machinery. Much in the way of arrears has to be made up in this essential work, and the present opportunity is being fully utilised. The workers themselves must feel the interval very acceptable. When operations are resumed workers and machinery alike will be better prepared for another great industrial push, and there is always at the back of everyone's mind the hope that it will prove the final victory effort. Prices of all descriptions are very firm. The principal quotations for home trading are as follows: Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export: Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ⅜in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 3/16in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12: all less 2½ per cent. except ship plates, angles and joists, packing iron and iron bars.

Scrap.

The market for heavy wrought iron scrap is exceptionally dull, but yet there is a good demand if dealers would give way. They are, however, firmer than ever in refusing to sell at the maximum figures, with the result that matters are practically at a deadlock; and it seems improbable that any business will be transacted unless the maximum prices are revised. In foundry scrap little new business has been reported of late, and this section of the market is certainly quieter. The maximum prices, however, are the only basis on which business

would be accepted by dealers. The demand for all descriptions of steel scrap continues on a large scale. Current prices are :—Steel scrap, heavy melting, £5 5s.; heavy forging, £5 5s.; steel turnings, £2 12s. 6d. to £2 15s.; steel scrap, light, £2 to £2 5s.; cast iron scrap, cupola metal, £4 10s. to £4 15s.; wrought iron plates and sectional material, ½in. thick and over, £6 5s.; heavy wrought iron scrap, ½in. thick and over, £5 5s.

The Coal Trade.

General conditions of business on the Northern coal markets show little or no improvement. Indeed, the situation is about as unsatisfactory as well could be. Sectional meetings of traders are now rather numerous for the private discussion of affairs, and one subject that is causing general cogitation just now is the approaching new Order concerning movements of coal which comes into operation next month. Traders are also worrying over new suggestions appertaining to marine insurances; and another topic of considerable interest is the possibility of securing some modification of the scheduled prices. It has been frequently stated that the commoner grades of coal were placed at a great disadvantage in competition with the prime classes, owing to the fact that no concession could be given by the collieries for the baser qualities, consequently the buyer would nearly always favour the superior sorts. There is therefore a determination to attempt to get the minimum lowered, so as to allow for a greater elasticity in competing for orders, and seeing that some modification has been sanctioned in the case of Cardiff coals, it is hoped that concessions may be granted for the Tyne coals. The trade position generally is not materially altered. Official absorption of coals still leaves room for improvement. There is, however, reported to be fairly considerable inquiry coming in from neutrals, particularly Scandinavia, and it is understood that odd lines continue to be placed in some instances, ranging from 1000 tons to 2000 tons. This is an indication that steps are being made to secure what supplies are possible prior to winter. There is said to be a little improvement in the position of the Northumberland collieries, a few of the loading turns having been filled, but these at the best only effect a temporary easement. The Durham pits are, as compared with the Northern section, rather better placed. Best steams are quiet, while second class steams and smalls —the latter especially—are plentiful and in poor request. There is a fair turnover in gas coals, while coking for export is slow. The bunker coal section continues slack. The coke market is fairly active, but exports are checked by the want of loading facilities. The home trade is very brisk. Quotations are as follows :—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; Tyne prime steams, 29s. 6d. to 30s.; Tyne prime seconds, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 28s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SHEFFIELD.

(From our own Correspondent.)

Cheap Electricity Wanted.

THE industrial atmosphere here is heavily charged with all sorts of rumours of further important combinations and other developments in the steel trade. Regarding the chief cause of some of these reports, I hope to be in a position before very long to make a statement, but in the meantime the stories seem to lose nothing by retelling—generally the reverse. The responsibility for most of them, I think, rests with persons whose interest in leading industrial concerns is limited to the market value of the shares; nevertheless, there is a substratum of truth, about which more may be heard presently. It may then be found that the share market aspect has not been entirely left out of the question. What is exercising the minds of many of the leaders of the steel industry is the question of a cheap and ample supply of electricity for power purposes. This provision is recognised as one of the keys to the industrial future. Whatever development plans are made the question of cheap electricity will have to be given its right place, or they will be robbed of a large measure of that success which should be looked for. As I mentioned in my previous letter, the Sheffield and Rotherham Corporations are displaying a considerable amount of activity in electrical provision. They are meeting an urgent call for present requirements, with, of course, a view also to the future; but whilst at the moment cost per unit is not of such importance as the increase in available current, after the war the two things will have equal significance, and real prosperity will come to that district where the current is cheapest. As I have already shown, Nature has endowed the South Yorkshire and Derbyshire districts with special facilities for securing a permanently cheap and full supply of electricity, the cost of generation being spoken of as possibly as low as four units for a penny; it therefore seems reasonable to anticipate that whatever extensions the Corporations concerned may be making, they should be made so as to become inter-workable, at some near date, with any practicable coalfields' scheme that may be entered upon, and that the common interests of the whole industrial district may be served rather than the narrow ambitions of a single corporation or company. The demand for the new power is growing daily, and at many works steam is being superseded, whilst every week almost brings reports of new electric steel melting furnaces, of one type or another, being put down. In many cases these take the place of crucible melting, though in the opinion of experts the crucible is never likely to be surpassed or equalled for some classes of work.

Railway Facilities.

Whilst discussing the threatened trouble among the locomotive engine-drivers with an official here, who is brought a great deal into contact with railways and their managements, I had pointed out to me some of the trials which manufacturers are expected to bear without murmuring. This official was strongly of the opinion that, judging by his experience of the several main lines serving the Sheffield district, railway administration has not been maintained under Government control at the same high level as in controlled steel firms. The latter, he added, are "controlled" on certain points, but there is still plenty of scope left for initiative and individual effort by the different firms. They have an incentive—curtailed, it is true, in these days of profits taxation—to do their utmost to increase turnovers and so mightily to raise output in the aggregate. It is not impossible for them, as has been repeatedly shown, to earn greatly increased dividends for shareholders. It certainly is the fact that ways and means exist whereby they can make important preparations for trade after the war in their own private interests. Their workmen on piece rates can earn record wages, and even their datal men have the opportunity of increasing earnings by well remunerated overtime. All these things are possible because the Government allows them plenty of scope and reaps the benefit by enormously increased output. "Now take the railways," he continued. "In pre-war days some of them were the best managed concerns in the world. Managements and responsible members of the staffs were alert and anxious for business. Now the work seems no one's in particular, and nothing appears to matter. Local officials and agents who were once anxious to solicit business repel your offers of traffic. That, of course, is chiefly due to war conditions, but it is having an enervating effect upon railway servants generally, from the higher officials down to the draymen, resulting in sheer wastage. Why cannot the Government put the railways on the same footing as controlled steel firms? Lay down the law of general user, leaving details to be attended to by the railway clearing house, and with compensating arrangements for wagon repairs done in other companies' sheds, and then allow all the companies to compete for business, as in pre-war days, handling it as best they can. Otherwise, let the Government take over the railways absolutely for the duration of the war, and see that they are run to the very greatest advantage." I give this opinion for what it is worth, and also because there is a strong current of feeling in manufacturing circles that the best is not being done. They do not blame the companies, who would no doubt prefer their own methods; but for all that they know that warehouses are choked up with goods awaiting despatch, and there is a feeling that traffic might be accelerated if the services of railwaymen were being used to greater advantage. As a matter of fact, the traffic actually being handled by the companies is stupendous, particularly in view of the rolling stock and rails taken off for service across the Channel; but granting all that, it does not follow that a very great deal more might not be done if similar methods of speeding-up were followed in railway matters, as have proved so successful in steel production.

Round the Works.

Very shortly now, I hear, a commencement is to be made with the erection of works at Chesterfield for a well-known firm of brass founders and rolling stock manufacturers. The works, which will have a siding on the Great Central, will form a new industry for the district. The Corporation has already passed the plans. There is said to be a decided falling off in overseas business of a general character, though, from what I can observe, matters in that direction appear to be keeping very well up. The latest business includes orders for tools for Bangkok, Manilla, Bombay, Penang, Genoa, Capetown, Buenos Aires, Malta, Boston, Lisbon, Calcutta, Singapore, Chittagong, Semerang, and Alexandria; sheep shears for Perth, Rosario, Falklands, Porto Alegre, Buenos Aires and Punta Arenas; machetes for Sekondi, Mombassa and Zanzibar; steel for Valparaiso, Rosario, Cawnpore, Calcutta and Melbourne; cutlery for Capetown, Barranquilla, Buenos Aires, Malta, Bombay, Penang and Montreal; electro-plate for Valparaiso; files for Toronto, Montevideo and Wellington; saws for Santander and Buenos Aires, and knives for Bombay, the Argentine and Vera Cruz. The Sheffield Corporation has placed contracts locally and in Stirling for about 1000 steel boiler tubes. The general demand for steel is a little inclined to be patchy at the moment, the pressure being very much greater in some directions than in others, the latter just now including high speed tool steel, though in that case if the call were greater it might be found that tungsten supplies are rather lagging again. Any quantity of carbon steel is urgently required, in which connection I learn that another Siemens furnace for acid steel has just got nicely into operation. This is a 50-ton furnace, but it is understood that it is being worked up to 60 tons. That, of course, is not unusual, for in the case of 8-ton electric furnaces melts of 10 tons are sometimes carried out. In mining machinery, shoes and dies for the Cape are not quite so active, though this is probably due more to the difficulty of obtaining export licences than to any relaxation of demand. A suggestion recently made in the States that Germany produced an aeroplane steel far superior to anything that could be done here has met with a very prompt repudiation. The production of this class of steel, especially of "stainless," for such things as valves, is increasing almost daily. The cutlery section of the steel trade, which has suffered severely through men being drafted into the Colours, finds a difficulty in keeping pace with the bare hand-to-mouth necessity of oversea customers, in addition to filling Government contracts at home. Here, as in the plate trade, a very close watch is being kept upon contract prices by the Government officials whose duty it is to supervise tenders, and I have heard many complaints that such business is now cut so fine as to be of little profit to manufacturers, who sigh for freedom to fill their works with foreign orders with big profit margins. There seems an excellent spirit in the cutlery industry, by the way, regarding trade after the war, and I should not be surprised to hear of important developments before very long.

The Master Cutler.

The Cutlers' Company has created a record. It has been in existence for 300 years, and last summer elected the same Master Cutler, Mr. W. H. Ellis, a director of John Brown and Co., Limited, for the third year in succession. Such an event had only once before occurred, viz., when about fifty years ago that distinction fell upon Mr. Mark Firth. Now Mr. Ellis has been elected for a fourth year, thus establishing a record, and an interesting feature is that the two great armament firms represented—Browns and Thomas Firth and Sons—are not only close neighbours, but have the most intimate business relations. In accepting office, Mr. Ellis said that such an election was only justifiable under very special circumstances, such as was brought about by the work in the hands of the company for various Government departments. Through the wide knowledge of technical subjects possessed by many of its members, the company was able to assist the Government in much important work. The formal installation takes place in October. Colonel Sir Albert E. Bingham, Bart., and Colonel H. K. Stephenson, both on active service, were re-elected senior and junior wardens, and the searchers were re-appointed, with the exception that Mr. James Neill takes the place of Mr. F. Scott-Smith, who has resigned the company, the vacancy being filled by the election of Mr. J. A. E. Paine, a director of George Wolstenholm and Son, Limited.

Coal Control Conditions.

From what I can gather, colliery circles are a little doubtful, so far, about the prospects of success for the Coal Controller's scheme for the rationing of London particularly. They point out that there has been no opportunity of accumulating stocks at depôts. It might have been different, they think, had London merchants, by the end of September, been able to deliver all their orders—a thing entirely out of the question, of course—but with hundreds of orders still on the books, some of them weeks in arrears, how is it possible, they ask, for merchants to commence the scheme fairly? The coal and coke committees have been sitting in the various areas of late to deal with the substitution of supplies that will be prohibited after September 8th, and, so far as can be learnt, the position has been fully dealt with. It is understood that after due consideration of the great part Sheffield is taking in the manufacture of war material and the enormous quantity of fuel coming into this district from areas that were to be prohibited—Derbyshire and Notts, for instance—the committee has exempted Sheffield so far as fuel for manufacturing purposes is concerned. Possibly one thing that influenced the committee was that experimenting with new fuels under the present stress of working conditions is not particularly desirable. Certainly, the dislocation of tonnage would have been enormous, whilst the haulage from other districts must have been very appreciably increased for purely local supplies, so that manufacturers will, doubtless, value the concession which is provided by the exemption, though for myself, I wonder if the circumstances requiring it should have been allowed to arise. It seemed so obvious that a serious disturbance of manufacturing fuel supplies must be inimical to the interests of a great munitions producing area.

Iron, Steel, and Coal.

Fair deliveries of special qualities of hematite iron continue to be made under the allocation arrangements, and this appears to be helped by the fact that materials for these on the West Coast are not quite so difficult to secure as in the case of other descriptions. Consumers here repeatedly hear stories of fresh furnaces being lighted up, or about to be; but there does not yet appear to be anything in them, though there still seem to be hopes of something of the kind being done. The position of all common irons is about unchanged. The make of acid steel locally is expanding, but the level of values is maintained. Steam coals are strong and active. Works are well supplied with large fuel and cobbles. Shipments to France and Italy are quite up to the recent average, but neutrals are getting nothing. The slack market is steady, though sellers' position is not quite as strong. House coals are unchanged. Best South Yorkshire steam hards are quoted 17s. 9d. to 18s.; best Derbyshire hards, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 17s.; best hard slacks, 12s. 3d. to 12s. 6d.; seconds, 12s. to 12s. 3d.; soft nutty, 12s. to 12s. 3d.; peas, 10s. to 10s. 6d.; and small slacks, 6s. to 6s. 6d. per ton at pit. In house sorts branch is quoted at 21s. to 22s., and best Silkstone 18s. to 19s. per ton at pit.

SCOTLAND.

(From our own Correspondent.)

Trade Conditions.

CONDITIONS in Scotland still show very little alteration. Energies are so bound up in promoting the production of munitions of all descriptions that ordinary trade is next to impossible. In spite of recent large additions to works and plants, war requirements are still considerably in excess of supplies, and the chances of the private consumer arranging for deliveries are more than ever remote. In any case, the time lost in securing permits is so extensive that it is questionable if the return is worth the trouble, apart from the advisability of sustaining some movement against the time when the exigencies of war render possible a return to former methods of procedure.

Wages.

The Special Tribunal appointed under Sections 6 and 8 of the Munitions of War Amendment Act, 1916, has issued an award implying the acceptance of the principle that where a woman is doing the same work and the same amount of work as a man, she shall be paid the same wages and enjoy the same conditions as the man she displaces. The Tribunal has found that the women employed by Messrs. Beardmore, in their machine shops at Parkhead Forge, Glasgow, as crane drivers, can undertake, after two weeks' experience, the whole of the work done by the men. It was decided, therefore, that after two weeks the women shall be paid the wages and allowances paid to the men. For the first two weeks the women will be paid at the rate of 6½d. per hour.

Pig Iron.

Great activity prevails in the pig iron trade.

Every effort is being made to increase the output of hematite, which is in urgent demand at the local steelworks. Forge and foundry qualities are also in constant request, and are becoming scarce, deliveries at times being unobtainable. Exports are still restricted to shipments to the Allies. Prices are firm and unchanged.

Quotations.

Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, No. 1, 126s. 6d.; No. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

All branches of the finished iron and steel trades are working under great pressure. At the steelworks plates and angles for shipbuilding and high tensile steel rounds are in ever increasing demand, and mills have difficulty in covering requirements. Consequently, exports are practically at a standstill. Quotations show no alteration. Black steel sheets are now very scarce, and after Government orders are satisfied nothing is left for ordinary distribution. The price remains about £18 5s. per ton net, f.o.b. Glasgow. Galvanised goods are off the market, apart from war necessities. Malleable iron makers, too, report large bookings for national purposes, with a correspondingly small amount available for private consumption. In fact, the ordinary brands of iron are being, to a large extent, substituted by a shell discard quality of material, and this is a fair index of the situation in the trade. "Crown" quality iron bars are quoted £15 5s. per ton for export, but business in this department is infinitesimal. The shipbuilding yards are exceedingly active, while engineering firms generally have a satisfactory amount of good work on hand at present.

Coal.

No indications of an improvement are as yet manifest in the Scotch coal trade. The industrial demand is comparatively healthy, and the household turnover is expanding, but business from all other sources is very meagre, both for home and export, particularly the latter. In the West of Scotland district the collieries are finding difficulty in avoiding broken time, and are not altogether successful. Values continue on last week's level. Ell coal, f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steam, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. In Fifeshire the position is discouraging. Irregular time is very prevalent, and there is no sign of an improvement. First-class screened navigations are quoted, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s. per ton. Conditions in the Lothians are much the same as in Fifeshire. The demand all round is very limited. Employment is unsatisfactory. Best steams are quoted, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The aggregate shipments from Scottish ports during the past week amounted to 170,655 tons, compared with 169,902 in the preceding week, and 211,701 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Variation of Schedule Prices.

Colliery owners have received a communication from the Coal Controller, who has agreed to the alteration of some of the prices in the schedule operating from June 28th last. There are also some additions to the classes, while best and second Admiralty large are in future to have the further designation of smokeless. There are very few changes so far as quotations for Cardiff are concerned. As expected, washed smalls are reduced from 24s. to 22s. 6d. and unwashed duff is now graded at 18s. for the best, 16s. for seconds, and 14s. for third quality. One effect of the fixing of values for unwashed duff at these prices is that patent fuel makers are inclined to agree now to the proposal that the schedule price for patent fuel for allied countries should be 30s., which is the figure the Coal Controller favoured. Makers, however, were opposed to it, and thought the price should be higher seeing that the price charged by colliery owners to them for smalls was 20s. per ton. The other alterations in the schedule concern the Swansea district more. Breaker duff is now 8s. as against 10s. formerly, and for steam bunkers (through) the price of 25s. is now altered to 23s. 6d. There are additions in the smalls section, and best steam smalls remain at 19s., but second qualities are now put at 17s., best cargo (through) at 23s. 6d., with second qualities at 22s. and gas (through) coals at 23s. 6d., with smalls at 21s.

Scheme for Pitwood Supply.

A scheme has been prepared for the supplying of coal mines with home-grown timber much on the same principle as that underlying the Coal Transport Reorganisation Order. The secretary of the Monmouthshire and South Wales Colliery Owners' Pitwood Association has received from the Coal Controller a demarcated map indicating the areas from which British coalfields are to draw their supplies of home-grown timber. The purpose is to economise inland transport facilities by restricting long-distance journeys as far as practicable, and to prevent overlapping of areas from which the several coalfields are drawing their supplies. It has been pointed out to the Controller that it is inconsistent with the principles of his coal transport scheme that timber hewn in Cardiganshire should be carried by rail to Northumberland, and that this anomaly might be removed and the work of the various district pitwood committees co-ordinated by making coalfields dependent for their home-grown supplies on the more adjacent forests. The map issued by the Controller shows the lines on which he is proceeding to meet these views. England, Wales, and Scotland have been split up into eight districts to be controlled by the pitwood committees for such districts. The area of supply for the South Wales coalfield is No. 6 on the map, and it includes the forests and woods in the counties of Cardigan, Brecknock, Radnor, Pembroke, Carmarthen, Glamorgan, Monmouth, Cornwall, Devon, Somerset (the greater part), Dorset, Wilts (except a small portion), Berks, and Hants. For the Forest of Dean and the Bristol coalfields, the area of supply is restricted to Gloucestershire, a portion of Herefordshire, and a small portion of Wiltshire.

Current Business.

There has not been much fresh business on the coal market this week, and the uncertainty regarding the railwaymen and the dispute of the tippers at Barry have not helped matters. The trouble at Barry, which resulted in the suspension of loading operations there, upset the arrangements of many shippers, and meant the diversion of coals and tonnage to other ports, which, as a consequence, have suffered to some extent from congestion. Many collieries have also been handicapped through wagons being held up, but on the whole the difficulty has been surmounted very well so far. Large coals have been very firm and scarce, but many exporters have found it no easy matter to secure berths for their tonnage at the ports where work has continued uninterruptedly owing to the pressure of the Admiralty authorities. Although there has not been much fresh inquiry on the market, the existing commitments of collieries are heavy and sufficient to keep them well engaged. Gas coals and house coals as well as all steam qualities have been in great demand. Collieries are now receiving certificates from the Coal Controller instructing them what contracts they must cease to deliver upon after September 8th under the Coal Transport Reorganisation Order, with the view of saving long railway haulage. So far they have not been notified what they are to do with their coals or what their position is in relation to the contracts delivery upon which is to be stopped. Bunker smalls continue to move off steadily under contract, but the demand is not as good as it has been, while cargo smalls are a very slack trade. Coke is firm at 47s. 6d., and patent fuel stands at 30s. to 32s. 6d., while pitwood rules about 58s. to 60s.

Later.

There is no change in the general market conditions. The resumption of work at Barry has come as a relief to the congestion at other ports, to which both tonnage and coals were diverted. The result is that there is no pressure at Barry, but it is expected that before the end of the week conditions will assume a more normal aspect. Large coals meet with good demand, but smalls are quiet. Washed beans and peas are in request. Patent fuel manufacturers have had an interview with the Coal Controller concerning the price to be included in the schedule for allied countries, and it has been agreed to fix it at 30s. Pitwood is unchanged at 58s. to 60s.

Schedule Values.

Steam coal: Best Admiralty smokeless large 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 22s. 6d.; unwashed duff, 18s.; second unwashed duff, 16s.; third unwashed duff, 14s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Western Valleys, 29s.; second Western Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. to 32s. 6d. Coke, 47s. 6d. Pitwood, ex-ship, 58s. to 60s.

Newport.

There has been very little change in the Monmouthshire coal section. Coals have moved off pretty freely as loading operations have been fairly active. Business has been moderately brisk in Western Valley qualities at schedule values, but small coals have been very quiet and are in plentiful supply. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d. Patent fuel, 30s. Pitwood, ex-ship, 58s. to 60s.

Swansea.

The anthracite coal trade has displayed an improved tone. Large descriptions have met with a stronger demand, and machine-made qualities have been more inquired for. The trade in steam smalls has been very quiet. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine-made large peas, 20s.; rubbly culm, 13s.; breaker duff, 8s.; billy duff, 6s. 6d. Steam coal: Best large, 30s.; seconds, 27s.; bunkers (through), 23s. 6d.; smalls, 19s.; second smalls, 17s. Bituminous coal: Through and through, 27s.; smalls, 24s.; gas, through, 23s. 6d.; gas, small, 21s. Patent fuel, 30s.

Tin-plates.

New business being concluded is comparatively small. Makers are very fully booked and prefer to wait for the schedule prices, which have not yet been sent out by the Ministry of Munitions. The returns show that at the end of July 235 mills were working as compared with 213 for June. At the end of July, 1916, the number was 377. Quotations: Block tin, £242 5s. per ton cash, £239 10s. per ton three months. Copper, £120 per ton cash, £119 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

AMERICAN ENGINEERING NEWS.

LARGE DOCKYARD CRANE.

A large locomotive crane has been built in the United States for the naval dockyard at the Panama Canal, and will be used for handling turrets, heavy guns, boilers, and machinery at the dry dock. It travels on two lines of 135 lb. flange rails, 22ft. apart, with eight grooved wheels under each side of the crane platform. The wheels are 37in. diameter, and half of them are driven by power. The underframe is 22ft. square, built up of heavy girders, and carries a cast steel roller path 23ft. diameter, upon which rides the revolving platform with the engines, boiler, and jib. The jib is a triangular truss, which is 115ft. long in the lower boom, and can be moved from a horizontal position through an angle of 66 deg. One engine, with 10in. by 12in. cylinders, operates the main and auxiliary hoists and the propelling machinery. The other engine, with cylinders 9in. by 10in., operates the luffing tackle, the whip hoist, and the swinging machinery. The main hoist can lift a load of 50 gross tons at 87ft. radius; the auxiliary hoist 15 tons at 97ft. radius, and the whip hoist 3 tons at 102ft. radius. The hoisting range is from 56ft. below rail level to 55ft. above rail level. The swinging can be done in either direction, making a complete revolution in two minutes. The speed of travel is 120ft. per minute in still air, or 100ft. per minute against a wind pressure of 10 lb. per square foot. Steam is supplied by a vertical fire-tube boiler 5ft. diameter and 10ft. high, carrying 125 lb. pressure. Oil fuel is used, there being a 250-gallon tank for oil and an 885-ton tank for water. The rear end of the revolving platform is counterweighed by slabs of concrete, in which steel punchings are embedded, weighing 250 lb. per cubic foot. The crane in working order weighs nearly 500 tons. It was built by the American Hoist and Derrick Company.

AMERICAN DOCKYARD WORKS.

The United States Navy Department now has improvement works under way at its dockyards representing an outlay of £16,000,000. This includes graving docks, an immense gun factory, storage warehouses, submarine bases, naval and aviation training stations, and a variety of buildings of all kinds. Also building ways for small and large vessels, shipbuilding shops, machinery and power plants. The general programme was adopted a few years ago, and was to extend over a term of years. With the declaration of war, however, all the work is being pushed, and, in addition, much extra work has been undertaken in connection with the establishment and equipment of camps and training stations for the navy proper and for the marines, aviation corps, &c. At the New York yard about £1,000,000 will be spent on ways for new battleships, warehouses, machine shops, and shipbuilding shops. At Philadelphia there will be a dry dock 1000ft. long, new machine shops, foundry and barracks, costing altogether about £3,600,000. At Norfolk there will be £4,000,000 spent on a dry dock 1000ft. long, new shops and water front improvements. At the Washington yard about £1,400,000 will be spent, mainly on the gun works, including a new shop for heavy guns, at a cost of £400,000. At the Puget Sound yard, £600,000 will be spent on facilities for building cruisers and auxiliary vessels for the navy. While there is no dockyard at Chicago, there is near that city one of the largest naval training stations in existence. This is a very complete and extensive establishment, and is now being enlarged so as to provide accommodation for 20,000 men. It is being used as a gathering point for recruits from the inland States.

TEN-COUPLED LOCOMOTIVES.

Following the lead of a number of other American railways the Southern Railway and the Pennsylvania Railway are introducing ten-coupled locomotives for goods traffic. They are of the 2-10-2 type. The Southern Railway has 55 of these engines, with 37 per cent. greater tractive force than the 2-8-2 engines, in the same service. All of them are machine fired, 50 having the Street stoker and the others the Hanna stoker. The cylinders are 28in. by 32in., with 14in. piston valves, operated by the Southern valve gear, which is of the fixed-link type. The driving wheels are 57in. diameter, and the middle—main—drivers have plain or flangeless tires. The boiler is 7ft. 4in. diameter, with 5234 square feet total heating surface, its fire-box is 8ft. by 11ft., with an oval combustion chamber, and 88 square feet of grate area. The boiler pressure is 190 lb. The engine weighs 185 tons, on a wheel base of 38ft. 8in., and has 147 tons on a driving wheel base of 20ft. 6in. The tractive force is 71,000 lb. The tender carries 9000 gallons of water and 12 tons of coal. The Pennsylvania Railroad is of 80,640 lb. tractive effort, with a maximum cut-off of 50 per cent., and the exceptional pressure of 250 lb. This tractive effort is at 7½ miles an hour, and becomes 44,500 lb. at 25 miles an hour. The cylinders are 30in. by 32in., with piston valves, and the Walschaerts valve motion. The driving wheels are 5ft. 2in. diameter, and only the leading and trailing wheels have flanged tires. The boiler is 7ft. diameter, and has a Belpaire firebox 10ft. 6in. by 6ft. 8in. The total heating surface is 4315 square feet, with 1060 square feet of superheating surface in addition. The weight of the engine is 188 tons, with 167 tons on a driving wheel base 22ft. 8in. The total wheel base is 32ft., or 73ft. including the tender. The weight of tender loaded is 90 tons. It is of the usual double-bogie type, and carries 9000 gallons of water and 17½ tons of coal.

ADVISORY COMMITTEE ON TERMINAL FACILITIES.

An advisory committee on terminal facilities has been appointed by the General Munitions Board of the Council of National Defence of the United States to promote the orderly, rapid, and careful loading of vessels with munitions and supplies required by the American armies in Europe and by the Allies. Mr. Francis L. Stuart, formerly chief engineer of the Baltimore and Ohio Railroad, is the chairman of the committee, which will at once begin consideration of these problems. It is expected that new terminals will be established at the principal ports, especially for the assembly and loading of supplies designed for the overseas forces and those of the Allies, so as to relieve existing terminals, with a view to preventing freight embargoes and congestion.

A HEAVY SINGLE-PHASE ELECTRIC LOCOMOTIVE.

SOME particulars of a heavy electric locomotive which has been built by the Pennsylvania Railroad Company are given in the issue of our contemporary, *The Engineering News Record*. This locomotive, which weighs 240 American tons—nearly 214½ of our tons—and has a tractive effort of 87,200 lb. at maximum speed, is intended for trial service on the company's electrified lines at Philadelphia, and possibly on the Norfolk and Western mountain electrification, in anticipation of the electrification of the Allegheny Mountain section of the Pennsylvania between Altoona and Johnstown, Penn. The locomotive is designed to deal with a load of 3350 short tons on a 1 per cent. gradient. Two of the engines, one pushing and one pulling, are to be able to haul a 3900 short ton train at 20.6 miles per hour up the 12-mile 2 per cent. gradient from Altoona to Gallitzin, or a 6300 short ton train up the 25-mile 1 per cent. gradient from Johnstown to Gallitzin.

A novel feature of the new locomotive is the placing of the motors ahead of the drivers, adjacent to the pony trucks. There are four motors, each with a rating of 1200 horse-power. Two motors are mounted on each unit. The units are articulated, but there is only one car body for the two units. As in the Norfolk and Western electrification, energy is derived from an 11,000-volt, single-phase, 25-cycle overhead system.

Only one normal operating speed, 20.6 miles per hour, is provided. This speed is the maximum that is considered safe for the heavy trains that the locomotives will be required to handle on the gradients of the Altoona division. A speed of 10.5 miles per hour can be obtained by connecting the motors in "cascade."

The locomotive is 76ft. 6¼in. long over all. It was built at the company's Altoona shops, the Westinghouse Electric and Manufacturing Company furnishing the electrical equipment.

THE CANAL CONTROL COMMITTEE.

THE Canal Control Committee has drawn the attention of manufacturers, merchants, exporters, and importers to the desirability of their using to the greatest extent possible the inland waterways of the country for the conveyance of all kinds of traffic, which can be conveyed by water.

The principal object for which the Canal Control Committee was appointed was to relieve the traffic on the railways by increasing the amount carried on canals. The railways have already been depleted of much of their equipment, considerable numbers of their experienced workers have gone into the Army, and the quantity of traffic of all kinds with which the railways have to deal has greatly increased. As a result they are, to-day, severely taxed, and it has become an urgent necessity that they should be afforded relief. One method of giving this relief will be to divert as much traffic as possible from railways to canals.

The Committee has appointed three Sub-Committees to assist it, namely—The Northern Sub-Committee, Aire and Calder Navigation Offices, Dock-street, Leeds, which will have under its control the Leeds and Liverpool Canal, the Aire and Calder Navigation, the Bradford Canal, the Sheffield and South Yorkshire Navigation, the New Junction Canal, the Calder and Hebble Navigation, the Rochdale Canal, and the Bridgwater Canals.

The Midland Sub-Committee, Norwich Union-chambers, Congreve-street, Birmingham, which will have under its control the Trent Navigation, the Weaver Navigation, the Staffordshire and Worcester Canal, the Birmingham Canals, the Coventry Canal, the Loughborough Navigation, the Leicester Navigation, the Shropshire Union Canals, the Worcester and Birmingham Canal, the Severn Navigation, the Gloucester and Berkeley Ship Canal, and the Erewash Canal.

The Southern Sub-Committee, Grand Junction Canal Company's Offices, 21, Surrey-street, Strand, W.C. 2, which will control the Birmingham and Warwick Junction Canal, the Warwick and Birmingham Canal, the Warwick and Napton Canal, the Oxford Canal, the Grand Junction Canal, and the Regent's Canal.

The Sub-Committees are composed of representatives of the Canal Companies, and of the carriers, with official representatives of the War-office, Ministry of Munitions, and the Railway Executive Committee, and each is presided over by an independent chairman.

Since the beginning of the war both the canal companies and the carriers on the canals have lost a considerable number of their employees, but the Canal Committee is taking steps to provide crews for as large a number of boats as possible, and it is hoped that a greater number of boats capable of carrying traffic will be available at an early date. The Committee points out that it is very desirable that all engaged in sending or receiving goods of any kind, but more especially those kinds which are suitable for canal transport, should realise the difficulties in connection with transport in this country, and that these difficulties are likely to increase owing to the requirements of the war. It is also desirable that all who have wharfage accommodation on, or who are in close proximity to, inland waterways, should not only use the existing facilities to a greater extent than heretofore, but should when practicable provide themselves with boats for canal traffic. Several firms at the present time have their own boats, but numbers of boats are not in use, and it is possible that arrangements can be made to secure some of these idle boats for any firms which may be able to use them. Information regarding these boats may be obtained on application to the Sub-Committees. It is thought that most firms would be able to find one or two men in their own employment over military age, who, after a few weeks' training, would be able to work the firm's boats.

Canal carriers are now in a better position to deal with traffic than they were, and the Committee hopes that the the arrangements made will enable a greater amount of traffic to be dealt with than has hitherto been the case.

SEVERAL years ago the Russian Admiralty completed three 50-ton submarines, in which were installed 50 brake horse-power Nobel-Diesel crude-oil engines. They still can be seen in operation on the river Neva at Petrograd.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

107,817 (9887 of 1916). July 13th, 1916.—FUEL INJECTION IN DIESEL ENGINES, Willans and Robinson, Limited, Victoria Works, Rugby.

The object of this invention is to provide an improved arrangement for separately pulverising the pilot charge adjacent to the point of introduction to the cylinder so as to obtain more efficient atomisation of the ignition fuel, and effect economy in the use of the lighter fuel. The invention consists in providing the fuel-valve body with a groove for the pilot charge and a port mounted in proximity thereto for deflecting and disturbing the flow of injection air. This may be effected by providing the fuel valve—Fig. 1—with a pulverising cone having right and left-hand spiral grooves A, and by forming in the corresponding conical portion of the fuel-valve chamber a groove B preferably circumferential adjacent the points where the spiral grooves in the atomising

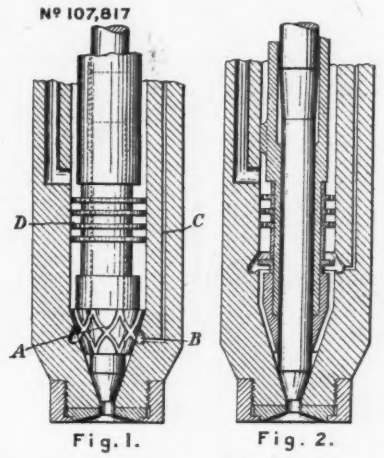
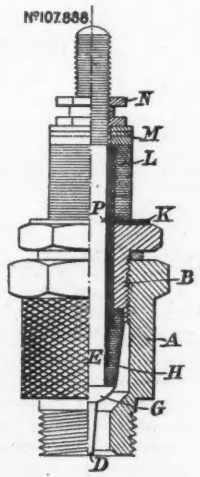


Fig. 1. Fig. 2.

cone intersect. The circumferential groove B in the fuel-valve body is in communication with a duct C for introducing the lighter oil constituting the pilot charge and the usual pulverising rings D for the heavier fuel for normal working of the engine are arranged at an appropriate distance above the aforesaid cone, so that a chamber of sufficient volume is formed to contain the requisite amount of injection air satisfactorily to atomise the pilot charge. With the improved arrangement above described considerable disturbance of the injection air will be caused at those points where the spirally arranged grooves in the atomising cone intersect, and as such disturbance takes place in immediate proximity to the aforesaid grooves or recess in the fuel-valve body receiving the pilot charge a very efficient pulverisation of the charge will be obtained. Fig. 2 shows a modification—*July 13th*, 1917.

107,888 (14,246 of 1916). October 6th, 1916.—SPARKING PLUG, Kenelm Edward Lee Guiness, Aranmore, Kingston Hill, Surrey.

This is an improvement in sparking plugs for engines working under high compression such as aircraft engines. The outer casing A is of the usual construction. The central electrode E is cylindrical along the greater portion of its length, but the tip D tapers, and just above the tip it is formed with the shoulder G to support mica rings or washers H. These latter are com-

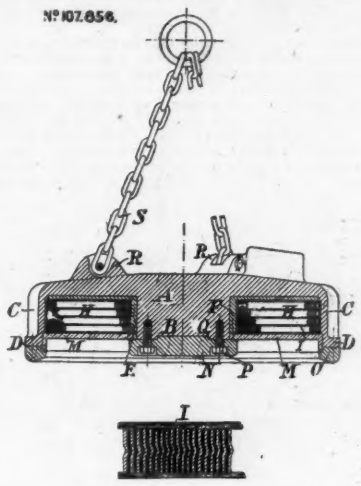


pressed on the shoulder G by the gland B. Above the gland several large washers K are arranged; above these again a pile of mica washers L, then a metal spring washer M and a nut N holding the central electrode in position. There is then, of course, the nut or other terminal, which holds the high-tension wire in position. The main insulation of the central electrode E comprises mica wrappings P which extend from the top of the washers L almost to the shoulder G.—*July 19th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

107,856 (11,812 of 1916.) August 19th, 1916. ELECTRIC LIFTING MAGNETS, Allen West, Lewes-road, Brighton, and others.

This is a magnetic lifting device with a circular yoke A, having a projecting central core B, and outer side walls C, flanged at D. The coils are wound on a large steel bobbin E whose core F is made a good fit over the central core B. The coils H are made from flat copper strip I, and the various sections are connected in series or in parallel by riveting or welding, and are joined to the terminals of the magnet by conductors passing through a cavity formed in the yoke A. The coils are protected from injury by external means by a shield or plate M of a non-magnetic material. This plate, which may be ribbed, is adapted on its



under side to make an air-tight joint with the side walls C of the magnet, and is held in position by the inner and outer pole shoes N and O of the magnet, which in turn are secured to the central core B and flange D respectively of the magnet by through bolts P. The pole shoes are formed with shoulders Q, in order the better to resist side blows caused by swinging the magnet against its load. The main casing is formed with lugs R for the purpose of attaching the chains S by which it is suspended.—*July 19th*, 1917.

107,903 (15,640 of 1916).—ADAPTER FOR LATHES, James Ridings, 124, Leamington-road, Blackburn, and others.

The essential feature of this invention is an arrangement of independent balls, rollers, or plungers, arranged within holes in the rim of a recessed part of the adapter, the balls or rollers under the action of a screwed conical ring serving to grip the work and hold it centrally. The adapter comprises a circular plate A recessed to receive the work so as to form an annular

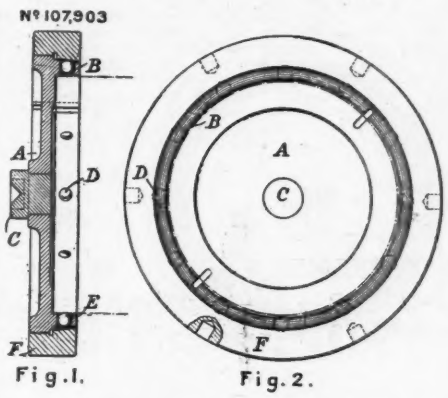
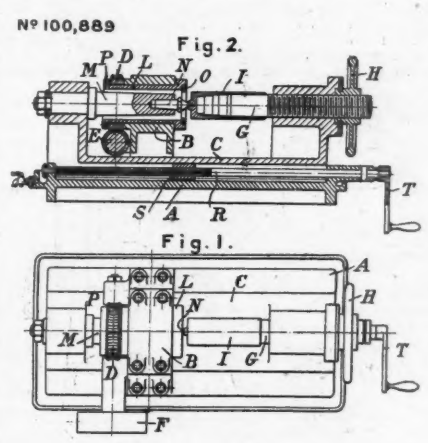


Fig. 1. Fig. 2.

flange B. Upon its other side the plate has a centre C to enable the adapter to be centralised, and in the rim is a number of evenly spaced radial holes E smaller at one end than at the other. Within the holes are steel balls D. The larger diameter of the plate is made with a left-hand screw thread on which the collar F is screwed, and the smaller diameter is tapered so that when the ring is rotated by means of a tommy-bar the balls are forced inwards to grip the work.—*July 19th*, 1917.

100,889 (9700 of 1916). July 10th, 1916.—MILLING MACHINES, Paolo Locati, 6, Corso de Umberto, Tortona, Alexandria, Italy.

Figs. 1 and 2 show details of the machine constructed for working the external cylindrical surfaces of shell cases or other hollow articles. The machine comprises a frame A on which is mounted a carriage C in such a manner as to be capable of sliding

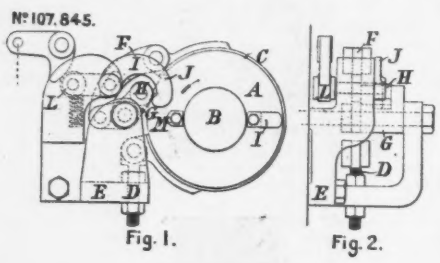


in a longitudinal direction, this displacement being effected by means of a screw R which engages in a nut S attached to the carriage C, and is operated by a handle T. The carriage C is provided at one end with a mandril G, and at the opposite end with a support M carrying a back-centre N. A support B fixed transversely on to the frame A carries a hollow s aft L mounted

within the support in such a manner as to be capable of turning coaxially with the mandril G and the back-centre N, the hollow shaft being provided at one end with a milling cutter O of annular shape, and at the other end with a toothed driving wheel D and with an adjusting nut P. The wheel D is provided with helical teeth and is operated by means of an endless screw E, the shaft of which is rotatably mounted in bearings attached to the support B, and carries keyed to it a pulley F receiving the driving force.—*July 10th*, 1917.

107,845 (10,925 of 1916.) August 2nd, 1916.—Power Presses. Harry Albert Griffiths, 8, Chad-road, Edgbaston, Birmingham, and another.

In power presses for operating on sheet metal this invention provides an automatic brake comprising the combination of a lever connected to one end of a brake band, a spring or weight-controlled pawl for engaging the lever and projections on the brake disc respectively engaging the lever for applying the brake and the pawl for releasing the brake. Fig. 1 is a side elevation, and Fig. 2 a rear elevation of the brake mechanism so constructed. A being a brake drum on the crank shaft B and encircled by a strap C, of which one end is secured by a bolt D to a bracket E on the press frame, whilst the opposite

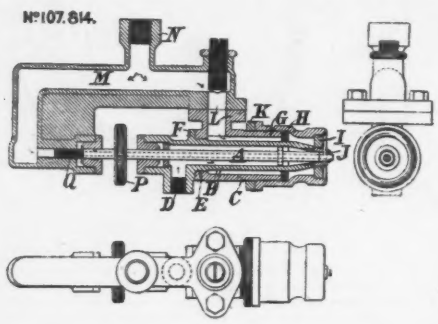


end is connected by a slotted link F to a bell crank lever G. The lever G is pivoted on the bracket and carries a roller H which is engaged by a contact piece I carried by the brake drum. When in the course of each revolution of the crank shaft the contact piece I engages the roller, the bell crank lever is so moved as to tighten the brake band on the drum, and before the contact piece leaves the roller a pawl J is forced by a spring acting on a lever L into engagement with the roller H, so that the brake is locked or held on during the required period of each revolution, corresponding with the up or return stroke of the press tool. By means of a second contact piece M on the brake drum the pawl is tripped at the required point in each revolution of the crank shaft to effect the release of the brake for the down stroke of the machine.—*July 19th*, 1917.

LIGHTING AND HEATING.

107,814 (9830 of 1916.)—Liquid Fuel Burners, Harold Newsom Davis and another, Diamond Foundry, Luton.

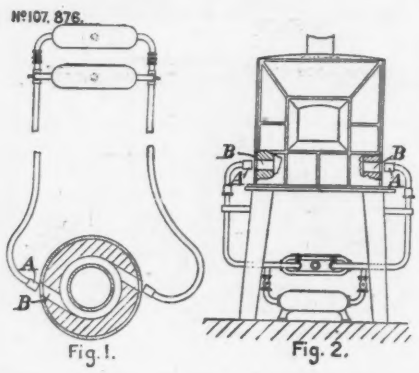
The improved burner comprises three concentrically arranged nozzles A, B, and C. The nozzle B for the supply of fuel is provided with a suitable screw-threaded connection piece D, and it is also formed with a threaded enlargement E and a collar F in its length, by means of which it can be held in engagement with the member C. This nozzle C terminates at its front end in a screw-threaded extension G over which screws a nozzle or cap H having a removable disc I at its end for co-operation with the nozzle end J of the nozzle B, and the arrange-



ment is such that the nozzle H can be adjusted without disturbing the pipe connections to the burner, and can be kept in its adjusted position by means of a lock-ring K. A flanged connection piece L is formed on the outside of the nozzle C, and to this flange is secured a branch piece M, having a common connecting nipple N and serving for the supply of air to the nozzles C and A. The inner nozzle passes through a packed gland and has a milled hand wheel P and outer screw-threaded extension tube Q. Means of adjustment of the air and fuel supply are provided.—*July 12th*, 1917.

107,876 (13,318 of 1916). September 20th, 1916.—Gas Fired Furnaces, Isaiah Hall, 29, Whitehouse-street, Aston, Birmingham.

This invention relates to gas-fired furnaces in which a blast of air under pressure is used to increase the rate of combustion.

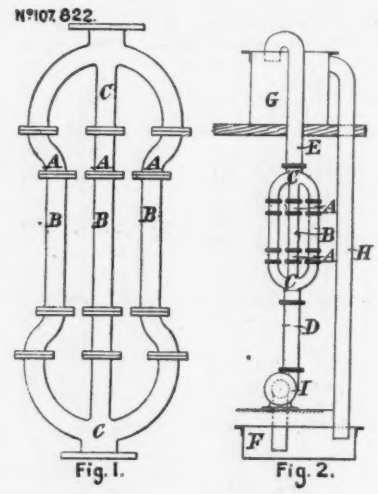


A number of burner units is used, in which are two distributing chambers for supplying the gas and air to the mixing chambers, which terminate in the nozzles where the mixture of combustible gas and air issues for combustion. The nozzles or burner caps A are arranged just outside apertures B in the furnace, so that the mixture of air and gas is enabled to induce a supply of secondary air, which thereby produces more perfect combustion and prevents the nozzles from burning out. The nozzles are flared or open-mouthed and are detachably connected to the extremities of the mixing chambers; they are further so arranged as to allow a current of air to pass freely into the aperture in the furnace, and with this object the aperture is larger in diameter than the exterior diameter of the nozzle. In the case of a crucible furnace—Fig. 1—the burners A are adapted to enter the furnace tangentially to avoid the flame impinging or striking directly on to the crucible, thus avoiding erosive action. Fig. 2 shows the arrangement of a muffle furnace.—*July 19th*, 1917.

MISCELLANEOUS.

107,822 (9942 of 1916). July 14th, 1916.—Electric Resistance Apparatus, Philip Henry Dawe, Dacre House, Victoria-street, Westminster, S.W.

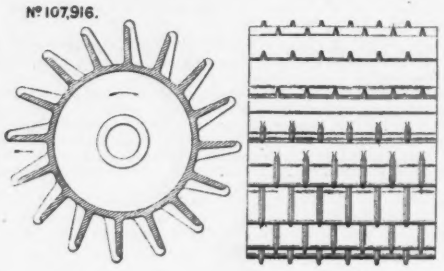
This is a resistance in which electric current is caused to act upon a liquid medium flowing through a conduit built up of alternate sections of insulating material and conducting material forming electrodes. Such a resistance is shown in Figs. 1 and 2. Three composite tubes are shown grouped together, each tube being built up of two insulating sections A of porcelain, an interposed metal section B and metal end sections C connected



with inflow and outflow pipes D, E. In Fig. 2 a circulating system is illustrated, including tanks F, G, at different levels, and connected by an overflow pipe H, the group of composite tubes being arranged between the tanks F, G, and having the inflow pipe D connected with a pump I, which forces liquid from the lower tank F through the inflow pipe and composite tubes to the outflow pipe D and tank G, from whence it returns through the pipe H to the lower tank.—*July 16th*, 1917.

107,916 (16,431 of 1916).—May 12th, 1917.—Pulping Engines, James Nuttall, Park View, Walmersley-road, Bury.

According to this invention ribs or projections are cast on or fixed to the blades or paddles, preferably radially to the roll and at a right angle and extending from the bottom or root



to beyond the top or nose of the blade, as shown in the accompanying sketches. The projections are preferably V-shaped in cross-section, the angle or edge of the V striking the material and splitting or breaking it up more rapidly and efficiently than the usual kind of blades.—*July 19th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been especially compiled for The Engineer *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of four of the patents given below £26 and on each of the remainder £18 have been paid in renewal fees.

No. 24,560/16.—Pistons. To obviate back pressure in the water supply of a piston-cooling device during the reciprocations of the piston, the water is supplied to the chamber in the form of a jet by a pipe adapted to telescope. The invention is stated to be applicable to the pistons of compressors, internal combustion engines, &c. Brandt, P., Germany. Dated November 15th, 1909.

No. 24,696/10.—Electric telegraphs and telephones. Electric oscillations or vibrations for use in telegraphy or telephony, with or without wires, are produced by the action of a rapidly rotating or vibrating magnetic system on a movable electrode of an arc. Arcs with movable electrodes controlled electro-magnetically or by sound waves are employed in receiving and amplifying the vibrations, and in the construction of microphones. Schiessler, J., Vienna.

No. 24,714/10. Range finders. To invert either the upper or lower image at will in coincidence telemeters two eye-pieces are used, which can be employed alternatively, a prism being fitted in front of the usual crossed prisms, and a reflective surface being arranged between the two parts of the prism. Optische Anstalt, C. P. Goerz, Akt.-Ges., Germany. Dated February 14th, 1910.

No. 25,006/10.—Fire extinguishing. In order to obtain a compact stream of extinguishing liquid from extincteurs, by preventing the liquid from absorbing and retaining carbon dioxide in the free state, and thereby causing the issuing jet to be broken up as it passes through the hose and nozzle, the liquid is saturated with salts, such as the alkali carbonates and alkali sulphates. Graaff, C., Berlin. Dated October 29th, 1909.

No. 25,014/10.—Telemeters. Objective and other lenses are mounted eccentrically in rotatable holders. The displacement of the images produced by rotation of the lenses is used for measuring, &c. Beck, P., Germany.

No. 25,295/10.—Lubricators. In a force feed lubricator, provided with a sight tube which can be temporarily interposed in the oil delivery passage, the supply of oil to the delivery pipe is regulated by means of an overflow connecting the delivery side of the pump to the oil reservoir, and controlled by an adjustable valve. A rotary pump draws oil through a number of suction pipes, and forces it through delivery pipes, past non-return valves, to the parts to be lubricated. Klinger, R., Lower Austria.

No. 25,320/10.—Meters. A steam, &c., meter comprises a cylinder, provided with a spring controlled floating piston, and having its ends connected respectively above and below a constricted portion of the main supply pipe. An indicating or recording device is attached to the piston-rod through a damping spring, and a damping device is also connected to the indicator rod. Gehre, M., Germany.

No. 25,345/10.—Stuffing-boxes. Elastic flexible non-metallic strips of leather, rubber or the like in contact with the piston-rod on their inner edges, are held in depressions between the metallic rings of compressor and other stuffing-boxes. Huhn, G., Berlin.

No. 25,494/10.—Shaft couplings. A flexible and yielding shaft coupling for conveying rotary motion comprises opposed discs, each having face teeth which engage between the convolutions of an annular helical spring located between the opposed discs. The teeth are preferably set at the bottom of annular grooves of semi-circular cross section forming seatings for the spring. A number of such springs can be arranged in or adjacent to one another, intermediate auxiliary toothed discs being introduced where necessary. Schluter, A. W. P., Germany. Dated March 21st, 1910.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W. 1.

ORDERS

For the week by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Platoon Commander C. Campbell.

Resignation.—Platoon Commander A. Gerard resigns his appointment.

Monday, August 27th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, August 28*th.*—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, August 29*th.*—Drill and Elementary Bridge Construction for No. 1 Company, Right Half Company.

Thursday, August 30*th.*—Drill and Elementary Bridge Construction for No. 2 Company, Right Half Company. Ambulance Class.

Friday, August 31*st.*—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Musketry.—All N.C.Os. and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at headquarters, and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the Orderly Room.

Note.—Unless otherwise indicated all drills will take place at headquarters.

By order,

Macleod Yearsley, Adjutant.

August 25th, 1917.

CATALOGUES.

Edward Le Bas and Co., London, have sent us a copy of their catalogue dealing with + G F + malleable tube fittings for steam, gas and water, in all sizes from ⅛in. to 6in. It runs to nearly 400 pages, and deals with about one thousand different fittings, illustrations being given in each case.

David Bridge and Co., Limited, Castleton, Manchester, have sent us a thoroughly interesting booklet dealing with scutching machinery for sisal and other fibres. The production is, we suppose, technically a catalogue: in actual fact, however, it is primarily a highly readable, concise guide to the cultivation of sisal and similar rope-making fibres and their preparation for the market. The writer of the pamphlet and the inventor of the scutching machinery mentioned in it is Mr. F. A. G. Pape, F.R.H.S., F.R.G.S. He reveals himself an ardent Imperialist, and urges eloquently an extension of the cultivation within the Empire of fibre bearing plants of the sisal type. British East Africa, it appears, is particularly important in this connection. The facts are that sisal is indigenous to Mexico and the West Indian Islands, but that the East African sisal as transplanted by the Germans some fifteen years ago is of much finer grade, and fetches a pound or so per ton more on the market. The sisal agave is, it seems, easily cultivated, and propagates itself abundantly and incidentally in an extraordinary manner. Allowing three years for the plant to come to maturity, some 1500–1600 acres of ground are, in Mr. Pape's opinion, requisite to carry on its cultivation on a satisfactory scale. Such a plantation should be capable of producing between 800 and 900 tons of fibre per year. The cost of production and of placing the fibre on the market is stated by Mr. Pape to be not more than £12–£15 per ton, while the present market price for good sorts is as high as £50. We have read the pamphlet from beginning to end with interest and pleasure, an indication perhaps that it is not a "catalogue" in the usual sense.

SEP 20 1917
UNIV. OF MICH. LIBRARY

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2

VOL. CXXIV.—No. 3218] LONDON: FRIDAY EVENING, AUGUST 31, 1917. [PRICE EIGHTPENCE BY INLAND POST THREEPENCE

AERO ENGINE PRODUCTION.

In View of the Urgent Demand for INCREASED AERO ENGINE or Aero Engine Parts Production, as supported by the maximum priority given to this class of work, it is of the greatest national importance that any FIRMS who consider they are in a

POSITION TO RENDER ASSISTANCE

should write to the

CONTROLLER OF AERONAUTICAL SUPPLIES,

Room 355, Air Board Office,
Strand, W.C. 2. 585

Required for the Service of the Government of India, in the Gun and Shell Factory, Cossipore, FIVE ASSISTANT FOREMEN, between 24 and 30 years of age, physically fit for service in India and qualified as follows:—

One, to act as Assistant Electrical Engineer.

One first-class Turner acquainted with shell machining.

One Draughtsman to take charge of Drawing-office. Must possess certificates in mechanical engineering subjects.

Two, experienced in the manufacture of Fuses, and able to make own gauges and tools.

All candidates must make sure that they could be released from their present employment, if selected.

TERMS.—Engagement for five years with option of extension if approved by Government. Salary 280 rupees per month, rising by annual increments of 10 rupees per month to 320 rupees per month. If re-engaged, 350 rupees per month. Overtime pay will be granted on certain conditions. Free quarters, medical attendance, and 2nd class passage out and home for selected candidate, wife and family.

Further particulars and forms of application can be obtained from the Director-General of Stores, India Office, Whitehall, S.W. 1. 562

PATENTS AND DESIGNS ACTS, 1907-1914.

CLUTCHES.

The Proprietors of British Letters Patent No. 21,637 of 1912 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to plate clutches and consists of improved means for disengaging the clutch and for lubricating the rubbing surfaces.

Address, BOULT, WADE and TENNANT,
111 and 112, Hatton-garden,
553 London, E.C. 1.

UNIVERSITY OF DURHAM.

Armstrong College, Newcastle-upon-Tyne.

PRINCIPAL: W. H. HADOW, M.A., D.Mus., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—

F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

Crystal Palace School of Practical Engineering.

Principal: J. W. WILSON, M.Inst.C.E., M.I.Mech.E.
Established 1872.

The New Course will Commence on Sept. 12th. New Students are entered on Sept. 11th, morning. Prospectus from the PRINCIPAL. 559

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M.Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE, comprising

FACULTIES OF ENGINEERING AND METALLURGY.

PROFESSORS IN THE DEPARTMENT.

Mechanical Engineering	W. RIPPER, D.Eng., M.Inst.C.E.	D.Sc.,
Metallurgy	J. O. ARNOLD, D.Met., F.R.S.	
Mining	F. E. ARMSTRONG, A.M.Inst.C.E.	M.Sc.,
Applied Chemistry	I. T. O'SHEA, M.Sc.	
Mathematics	A. H. LEAHY, M.A.	
Physics	S. R. MILNER, D.Sc. (Acting Prof.)	
Chemistry	W. P. WYNNE, D.Sc., F.R.S.	
Geology	W. G. FEARNSIDES, M.A.	
Electrical Engineering	E. H. CRAPPER, M.I.E.E. (Lecturer).	B.Eng.,
Civil Engineering	J. HUSBAND, B.Eng., Inst.C.E. (Lecturer).	A.M.
Glass Technology	W. E. S. TURNER, (Lecturer).	D.Sc.

The subjects in which courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes courses in Civil, Mechanical, Electrical and Chemical Engineering, and students specialise in one or other of these branches in the third year of their course. The course in Engineering extends over three years and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' courses are arranged for Works' Pupils, who come to the University from works in Sheffield, or from other centres, taking six months' study at the University and six months' practice at the works each year.

The DEPARTMENT OF METALLURGY includes (a) the Metallurgy of Iron and Steel, and (b) the Metallurgy of the Non-ferrous Metals. The course in Metallurgy extends over three years, and prepares for the Degree of Bachelor of Metallurgy (B.Met.) or for the Associateship of the University in Metallurgy. The equipment of this Department is on an exceptionally complete and practical scale.

The work of the DEPARTMENT OF COAL MINING includes a three or four years' Diploma Course, consisting of six months at the University and six months at a Colliery.

The DEPARTMENT OF APPLIED CHEMISTRY deals specially with the subjects relating to various branches of Coal Mining, and of the Coal and Coke Industries.

The DEPARTMENT OF GLASS TECHNOLOGY provides (a) a Diploma Course requiring systematic study of the science and practice of Glass Manufacture for a period of three years, and (b) Part Time and Special Courses.

The LECTURE COURSES of all the Departments are supplemented by Practical Training in Laboratories, Workshops, and Foundries fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part Time Courses are arranged for students who desire to take special portions of any of the regular courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917.

W. M. GIBBONS,
139 Registrar.

UNIVERSITY OF LONDON.

King's College.

FACULTY OF ENGINEERING.

Complete COURSES of STUDY, extending over either three or four years, are arranged in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.

The four years' course provides, in addition to the academic training, opportunity for practical training in "WORKS."

HEADS OF DEPARTMENTS.

Professor D. S. CAPPER, M.A., M.Inst.C.E.	Mechanical Engineering.
Professor A. H. JAMESON, M.Sc., M.Inst.C.E.	Civil Engineering.
Professor E. WILSON, M.Inst.C.E., M.I.E.E.	Electrical Engineering.
Dean	
Professor S. A. F. WHITE, M.A., Professor J. W. NICHOLSON, M.A., D.Sc.	Mathematics.
Professor H. JACKSON, F.I.C., Professor A. W. CROSSLEY, D.Sc., F.R.S.	Chemistry.
Professor O. W. RICHARDSON, D.Sc., F.R.S.	Physics.
Professor A. K. HUNTINGTON, M.I.M.M.	Metallurgy.
Mr. W. T. GORDON, D.Sc., F.R.S.E.	Geology.

Considerable additions have been made to the Engineering Department. These include a large drawing-office and lecture rooms for the Mechanical and Civil Engineering Departments and lecture theatre and rooms for research, including Wireless Telegraphy for the Electrical Engineering Department. There are five laboratories well equipped with engineering plant and apparatus for the purpose of teaching and research.

Next term begins on WEDNESDAY, OCTOBER 3RD.

For full information apply to the DEAN or the SECRETARY, King's College, Strand. 505 1

The Royal Technical College, GLASGOW.

SESSION 1917-18 BEGINS ON SEPTEMBER 25th.

The Diploma of the College is granted in the following Departments:—Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining, Naval Architecture, Chemistry, Metallurgy, Building, Textile Manufacture, Dyeing, and Sugar Manufacture. A course for a Joint Diploma in Architecture has been arranged in conjunction with the Glasgow School of Art.

The Diploma Course extends over either three or four sessions, and the average fee per session is £12 12s.

The College is affiliated to the University of Glasgow, and the degrees of the University in Engineering and Applied Chemistry are open to its students.

Full Courses of Instruction are also provided in the Schools of Navigation and Bakery.

Prospectuses will be sent on application to the DIRECTOR. 498

Oxy-Acetylene Welding.—A COURSE of LECTURES and practical instructions in conjunction with the Ministry of Munitions will be given at the Northern Polytechnic, Holloway, N. 7. First Lecture Monday, September 3rd.—Further particulars to be obtained from the SECRETARY. 522

Ashton-under-Lyne, Stalybridge AND DUKINFIELD (DISTRICT) WATERWORKS.

The Joint Committee REQUIRE the SERVICES of a thoroughly capable and energetic ENGINEER to take the entire charge and management of the Out-door Department of their Undertaking.

The area of supply is about 33,470 acres, and includes four Municipal Boroughs and two Urban District Councils within their Contributory district, and several adjoining Urban Council Districts within their non-contributory district, the population of the whole being about 140,000.

There are twelve impounding and service reservoirs situate in different districts having total capacities of nearly 1090 million gallons.

Applicants must have had considerable experience in the preparation of plans, estimates and reports of work required, superintending the laying of mains and services and control of men, together with experience of the latest systems of mechanical pressure filters.

Applications, stating age, salary, experience, &c., and enclosing copies of three recent testimonials, to be sent to the undersigned not later than the 5th day of September, 1917, endorsed "Engineer." Canvassing prohibited.

LEES BUCKLEY,
Secretary.

Waterworks Department,
Town Hall Chambers,
Ashton-under-Lyne,
10th August, 1917. ▲

Association of Engineering and SHIPBUILDING DRAUGHTSMEN.

POST OF ORGANISING SECRETARY.

The Representative Council of the Association of Engineering and Shipbuilding Draughtsmen invite

APPLICATIONS FOR THE POST OF GENERAL SECRETARY.

The salary attached to the post is £350 per annum, rising by increments of £25 to a probable maximum of £400.

The successful candidate must be prepared to give his entire services to the office, and to reside in Glasgow until 1st March, 1918, when headquarters will be removed to London.

Six months' notice in writing to terminate the agreement on either side.

Applications should state age, qualifications and organising ability, and six copies should be forwarded, not later than 21st September, to the SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 94, Hope-street, Glasgow.

Envelopes to be marked "G. S." 600

The Port of London Authority REQUIRE the SERVICES on the Temporary Staff of several DRAUGHTSMEN thoroughly experienced in the design and construction of one or more of the following branches of Engineering:—

(a) Heavy Movable Bridges and Steelwork.
(b) Lock Gates and Caissons.
(c) Docks, Entrances, Passages, Walls, Jetties, &c.
(d) Railways.
(e) Mechanical Appliances.
(f) Hydraulic Installations.

State age and salary required, medical category (if of recruitable age), present salary and employment, and when at liberty.—Apply by letter only to the CHIEF ENGINEER, 109, Leadenhall-street, E.C. 3. 587

Commissioners for the Port of RANGOON.

FOR SALE:—TWIN SCREW STEEL SELF-PROPELLING SUCTION DREDGER, "PELICAN," and FLOATING PIPE LINE, built by Messrs. W. Simons and Company, Renfrew, 1908.

DREDGER.—Length 208ft. by 36ft. beam; maximum draught 10ft. 7in.

Two sets triple expansion surface condensing propelling and two sets pumping engines, with 4 boilers; two 30in. centrifugal pumps with nominal capacity of 30,000 cubic feet of sand or silt per hour, lifting from a depth of 35ft. and delivering through 3000ft. of pipe line.

FLOATING PIPE LINE.—in 56 lengths of steel pipe, 50ft. long and 40in. diameter, on circular steel pontoons, 26ft. diameter and 4ft. 4in. deep.

Further particulars may be obtained from
The SECRETARY,
Commissioners for the Port of Rangoon,
520 Post Box No. 85,
Rangoon, Burma.

Wanted, the Services of a Highly trained TECHNICAL ENGINEER for a short period, for the purpose of compiling a technical catalogue illustrating the manufactures produced by a very large firm, and containing useful information for Engineers, Architects, Builders, &c. Liberal terms to suitable man.—Address, 551, "The Engineer" Office. 551 ▲

Wanted Immediately, by Large Manufacturing Firm, a capable SUPERINTENDENT ENGINEER, for a large multiple effect evaporating plant and accessories. A man with good Sugar experience will be especially suitable. Good salary to the right man. No one of military age need apply, unless absolutely rejected for Army service.—Reply, giving experience, salary required, and age, to 542, "The Engineer" Office. 542 ▲

Works Engineer Required for a large Shipbuilding and Engineering Works. Must be a thoroughly experienced man and capable of taking complete control as regards the maintenance and upkeep of the Works Plant, Power Station, Hydraulic and Pneumatic Services, Cranes, &c.—Address, stating age, previous experience, and salary required, to 571, "The Engineer" Office. 571 ▲

Electrical and Mechanical Engineer accustomed to laying out plant for rolling mills, wire drawers, &c., and able to make own plans. State age, experience, and wages required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and No. A3581. F918 ▲

Electrical Power Engineer, with experience in A.C. and D.C. Motor Factory Equipments, preferably with drawing-office or test experience, for large manufacturing firm (controlled).—Apply, stating experience, age, and salary required, to your nearest Employment Exchange, and quote "The Engineer" and No. A3537. No person already engaged on Government work need apply. 511 ▲

Engineering Assistant Required by a Public Works Contractor; must be a good Draughtsman and have had a Technical Training.—Address, 602, "The Engineer" Office. 602 ▲

Engineer's Buyer Wanted. Preference given to one having experience in Locomotive and Light Railway Work, also Estimating (he would be required to deal with all shop orders and material). Only competent, experienced men need apply, and no person already on Government work will be engaged.—State experience, age, and salary required to your nearest Employment Exchange, quoting "The Engineer" and number 468. 468 ▲

First-class Experienced Estimator WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 ▲

Jig and Gauge Inspector Wanted at Controlled Factory in the Midlands. Only first-class men and those not already engaged on Government work will be considered.—Apply, at your nearest Employment Exchange, quoting "The Engineer" and reference No. A3583. 508 ▲

Manager Wanted for the Midlands, thoroughly competent to UNDERTAKE CONTROL of the Manufacture of Milling Cutters, Reamers, Hobs, Gear Cutters, &c., of all descriptions, from the blank to the finished tool. Must be experienced in handling both male and female labour, able to fix rates, and capable of introducing the most up-to-date methods of production.—Write, stating full details of experience, also age, and salary expected, to U.G.C., c/o Streets, 30, Cornhill, E.C. 3. 519 ▲

Manager Wanted to Organise and afterwards Superintend Ball Bearing Factory.—Address, in confidence, giving age, experience and salary required, to 573, "The Engineer" Office. 573 ▲

Metallurgist as Assistant to Head of Hardening Dept. in large manufacturing works. Experience of Case Hardening essential. No one on Government work will be engaged without consent of present employer.—Apply, with fullest particulars, to your nearest Employment Exchange, mentioning "The Engineer" and number 603. 603 ▲

Rate Fixer Wanted for Engine Works. Accustomed to modern machine methods for medium and heavy classes of work. Apply with full particulars as to experience and wages expected. Good opening for experienced man. No one already on Government work need apply.—Apply your nearest Employment Exchange, mentioning "The Engineer" and No. A3567. P921 ▲

Required, a Thoroughly Experienced working charge ENGINEER for a Roofing Felt and Asphalte Factory. One with a good general millwright's experience preferable. The appointment is for a permanency. Adequate assistance is given, all light repairs being executed in an equipped small engineering shop in the factory. Position East End of London. Applicants must show first-class credentials and be unquestionably experienced.—Address, in the first place, with full particulars as to capabilities, 502, "The Engineer" Office. 502 ▲

Research Physicist Wanted for large Scientific Instrument Factory. Graduate in Science, with workshop experience preferred.—Reply, stating age, salary, and full details of experience, to 480, "The Engineer" Office. 480 ▲

Wanted, Confidential Clerk for Manager's Office, large engineering firm in Manchester district. Good stenographer, accustomed to engineering terms. Up-to-date office arrangements, &c. No one already on Government work will be engaged. State age, full details of experience, and salary required.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3566. 497 ▲

Works Accountant Required for a large Motor Vehicle Works employed solely upon Government work; must have had good experience in the organisation and running of an up-to-date Cost Department. No one at present engaged upon Government work can be employed.—Apply, giving particulars of experience and salary expected, to the nearest Employment Exchange, quoting "The Engineer" and number 597. 597 ▲

Accountant Required, by an Old-Established Company, for Works in Liverpool. State experience and salary required. Also Assistant to Accountant.—Apply, Box 2707, Willings, Moorgate-street, London, E.C. 2. 558 ▲

Wanted for the Electrical Engineer's Dept. of a large Steel and Iron Co. in the North Midlands, several good DRAUGHTSMEN who have had experience in the design of E.H.T. and H.T. Substations, and the layout and installation of motors, cables, switchgear, and special appliances in connection with the driving of heavy Steel Works or other similar plant engaged on varied classes of War work. Applicants are requested to give their age, and submit references and details of their training and experience, also to state the wages required, and the earliest date upon which they could take up their duties if selected for the post. No person already employed on Government work will be engaged.—Apply, nearest Employment Exchange, mentioning "The Engineer" and number 463. 463 ▲

Wanted, Good Jig and Tool DRAUGHTSMAN for Aeroplane Engine Work.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3614. No persons already on Government work need apply. 581 ▲

Wanted, Two Competent DRAUGHTSMEN ineligible for Military Service, experienced in Steel Constructional Work and Factory Buildings, for large Works, London district, where extensive alterations involved.—Write, stating age, wages expected, experience and reference to DRAUGHTSMAN, c/o. Abbott's, East-cap, London, E.C. 3 F940 ▲

Chief Lady Tracer Required to Take Charge of small Tracing Department on Government work in South of England. Only those who have had charge of a tracing staff for at least one year need apply.—Apply, stating age, experience, and present salary, and enclose sample of work, to nearest Employment Exchange, mentioning "The Engineer" and No. 566. No one at present on Government work will be engaged. 566 ▲

Draughtsman for General Engineers in London. State age, experience, and wages required. No person resident more than 10 miles away or at present on Government work will be engaged.—Address, P. P., c/o. J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 543 ▲

Draughtsman, Junior, Mechanical, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3234. 12 ▲

Draughtsman (Mechanical or Electrical) REQUIRED in London (West) by a firm of Engineers engaged on Admiralty work. No one living more than ten miles away or already employed on Government work will be engaged. State age, experience and salary required.—Address, 435 "The Engineer" Office. 435 ▲

Draughtsman, Mechanical, One used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3390. 124 ▲

Draughtsman Required for service in an Admiralty Department, preferably with experience of Marine Engineering.—Applicants to state age, salary required, and details of previous experience (by letter only) to Box No. 1194, c/o Messrs. R. F. White and Son, General Advertising Agents, 33, Fleet-street, E.C. 4. 521 ▲

Draughtsmen Required by Large controlled firm in the Midlands (a) with experience of General Engineering and the Layout of Plant; (b) with experience of Machine Tool and Automatic Machine Design. Permanent positions for suitable men. No person engaged on Government work will be employed.—Apply, stating experience, age, salary required, and when at liberty, to your nearest Employment Exchange, quoting "The Engineer" and number 570. ▲

Draughtsmen Wanted, Thoroughly capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 ▲

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Locomotive Draughtsmen Required for works in the North of England. State age, salary required, and details of previous experience. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 604. 604 ▲

Mechanical Draughtsman Required with general experience and good knowledge of French by Westminster Firm of Engineers. Good salary to suitable man. No one at present on Government work or residing more than 10 miles away will be engaged.—Address, 566, "The Engineer" Office. 566 ▲

Several Lady Tracers Required for South of England.—Apply, stating age, experience, present salary, and enclose sample of work, to nearest Employment Exchange, mentioning "The Engineer" and number 567. No one at present on Government work will be engaged. ▲

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SITUATIONS, FOR SALE, &c.,
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PAGE LXIV

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Wanted, Several ½-yard Tip WAGONS, also 200 to 300 yards of narrow gauge TRACK, with Turntables, &c.—GAZES, Limited, Walton-on-Thames. 560 F

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One HYDRAULIC PRESS, with 12in. ram, 25in. by 24in. platen, double hand pump, made by Middleton; short stroke.
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Nine Belt-driven AIR COMPRESSORS, by Reavell, each four cubic feet capacity, and two ditto by Johnson, each 5 cubic feet capacity.
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For Sale, Engines (2) Locomobile (Wolff type) by Robey. 110 H.H.P., superheated, jet condensing, cylinders 10½ × 17½ by 18in. stroke; 170 revs., 160 lbs. w.p. Seen under steam. Almost new.—A. UNDERWOOD, 3, Queen-street, E.C. 577 G

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For Sale, Lancashire Boiler, 34ft. by 8ft. dia., 100 lb. press.; CORNISH BOILER, 26ft. by 6ft. dia., 130 press.; with fittings, now fixed; immediate delivery.—Address, 478, "The Engineer" Office. 478 G

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Belt-driven three-throw HYDRAULIC PUMP, 2½in. plungers	£65
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THE DISTRIBUTION OF ESTABLISHMENT CHARGES.

By F. T. CLAPHAM, M.I. Mech. E.

In these days companies manufacturing a number of specialities often find it desirable to run their works in departments.

This answers a two-fold purpose.

First, it enables a closer supervision of manufacture, and, secondly, it admits of a separate departmental cost being kept. This is important, for only by this means is it possible to know with certainty whether a particular branch of manufacture is profitable or not.

Very often when a concern is run in departments, insufficient care is taken in subdividing or allocating the establishment charges in fair proportion. For instance, a firm may have five departments, each department under a separate manager, the five departmental managers in turn responsible to a general manager. The salaries of the managers and their permanent staff are very rightly debited to their respective departments. The charges of the general office staff and running expenses are then divided by five, and each department is debited with one portion. This is utterly wrong, and puts the whole scheme out of proportion. Where departmental costs are made up on such a basis, it is easy to understand why some departments are full of orders and others cannot get anything to do.

Costs are the compass of the selling department; they point out the price. If the cost is made up on false premises, the selling price is also false. If one department bears too great a share of general charges, another carries too little. The department which is overcharged cannot get orders against its competitors; the other obtains them with ease.

The market for goods sold under cost price is unlimited!

Another custom is to run a works in departments, keep the shop costs separate, and debit each department with its establishment charges at the end of the year, such charges being a percentage based on the turnover. For example, let us assume the turnover is £100,000 and the charges on this amount are 20 per cent. Then £20,000 is required. If the departments have approximately the same turnover, they have £4000 each to earn. The year's trading might turn out as follows, and a "turnover" charge would be

	£		£	
Dept. 1	12,000	20 per cent. equals	2400	charges.
Dept. 2	30,000	,,	6000	,,
Dept. 3	6,000	,,	1200	,,
Dept. 4	24,000	,,	4800	,,
Dept. 5	28,000	,,	5600	,,
	100,000		20,000	

Hence we get this paradox. The more work a department turns out the greater the amount of the establishment charges. The less it turns out the lower the charges. Presumably if no work is done at all there are no charges to meet, which is arrant nonsense. The fixed charges are there just the same.

It is possible that a firm of auditors who go over the accounts of a company at the end of the year may state "Your establishment charges work out at 20 per cent. of your entire turnover." Quite true, but the auditors would not appropriate the charges to the several departments on such a basis—quite the contrary. They know that the department with the smallest floor space and the best machinery very often carries the highest proportion of establishment charges. Why? Because there are fewer men comparatively to the amount of capital sunk in a machine shop than there are in a foundry.

If an operative is absent from a machine shop by illness or otherwise, the department loses, not only the services of the man, but of his machine too. In a foundry this is not the case, and production is not retarded in anything like the same proportion.

Some firms persist in making up an estimate by putting down items of material, labour, &c., casting them up, and then adding a "turnover" establishment charge, affirming that though this method may be rough, inaccurate and unscientific, "what we lose on the swings we gain on the roundabouts."

There is no excuse or room in these days for such clumsy work. Estimating on such lines is positively dangerous. The following figures explode the fallacy of "turnover" charges.

For brevity we will assume that the estimates include three items only—material, labour, and establishment charges.

Estimate of four Steel Tanks.

	£	s.	d.
Steel plates, 20 tons at £13 per ton	260	0	0
Labour £4 per ton	80	0	0
	340	0	0
Establishment charges, 20 per cent.	68	0	0
Prime cost	408	0	0

Estimate of Steel Platform.

40 tons of rolled steel joists at £12 per ton	480	0	0
Labour at 12s. 6d. per ton	25	0	0
	505	0	0
Establishment charges, 20 per cent.	101	0	0
Prime cost	606	0	0

It will be seen that—

40 men at £2 per week, plus use of machinery, earn in charges	68	0	0
12½ men at £2 per week, plus use of machinery, earn in charges	101	0	0

Both estimates cannot be right. Indeed, it is obvious that both of them are hopelessly wrong.

A certain firm, which shall be nameless, agreed to machine an engine bed belonging to a neighbour. The casting arrived in due course, was put on the planing machine, and turned out finished in about eight days. The cost was made up as follows:—

	£	s.	d.
Man's time machining—8 days at 7s.	2	16	0
Help to get it on and off the machine		5	0
	3	1	0
Establishment charges, 20 per cent.		12	2
Prime cost	3	13	2

As scarcely any machine shop can work with less than a 150 per cent. charge based on labour, the cost should have been

	£	s.	d.
Man's time machining, 8 days at 7s.	2	16	0
Help to get it on and off the machine		5	0
Establishment charges, 150 per cent.	4	4	0
Prime cost	7	5	0

Comment is needless.

How then is it proposed to allocate establishment charges?

First, the value of the building or shops which form a department and of their fixed machinery must be ascertained, their depreciation and repair allowed for, together with the cost of power, light, heating, water, loose tools, oil, belting, &c., travellers' commission. The rates and taxes, advertising expenses, general office charges, stationery, postage, telegrams, &c., should be charged in fair proportion on the capital value of the department. There remains the salaries of the manager, foremen, time and cost clerks, and such labour that cannot be directly charged to any given job or contract, and is commonly called unappropriated labour, such as crane drivers, engine driver, general labourers, belt repairer, and man who oils shafting and bearings. The annual amount of these charges do not vary much, and they can therefore be fixed for the current year at their cost in the year before.

Having obtained these figures, which we will assume to be £3000, we divide them by twelve, and find that the amount of establishment charges, which must be earned to cover bare expenses, is £250 per month.

We have now a working basis. How can it be applied?

Here is one method.

Get the actual shop costs made up quickly, tabulate them monthly, and ascertain exactly what you have earned.

First and foremost it must be realised that there is no profit on an article until it is sold; therefore when one department does work for another, it should be charged out at bare cost, plus the establishment charge. This charge must be met, and must therefore be put on all work produced or handled by the department.

Profiteering between departments is sheer nonsense.

It is possible for four out of five departments to show a profit by the one trading on the other. The fifth department, which does the actual finishing and dispatching of the articles, showing a loss for no other reason than that the partly finished goods are charged to it at a price which already carries two or more departmental profits.

In the case of unfinished work it will be generally found in practice that the amount of work brought forward from the preceding month is about balanced by the value carried over to the next month.

Monthly costs could be tabulated as follows:—

Job. No.	Material.	Labour.	Total.	Contract value.	Amount earned towards charges.
	£	£	£	£	£
740	100	90	190	270	80
656	80	42	122	150	28
561	400	100	500	650	150
702	30	20	50	70	20
To other depts.	200	70	270	—	70
					348

In actual practice five items would constitute a month's output in scarcely any trade, but the results of a month's working can be set out on this basis, whether the items are many or few.

The charges of this department are £250 per month, and the table proves that £348 has been actually earned. There is therefore a profit of £98. By this simple means a department can always be checked for earning capacity, and, moreover, if the earned charges are cast up and carried on collectively in each month the total amount earned at any given month can be readily ascertained.

Assume that at the end of six months the table proves that eight months' charges have been earned. There remain six months to earn the remaining four months' charges in. It may be that a good running order is offered which will fill the department with work, but which is not such a good paying line as other things. Given the charges well earned to date, there is now a chance to make certain of earning the rest by accepting this order, running the machinery for all it is worth to make up on quantity and a running line what is lost in price.

In times of slackness, when orders at good prices cannot always be booked, such a chance as this means the salvation of a department. If the order is accepted and properly handled, the full charges of the year are earned plus a profit. If it is refused it may mean that no sufficient quantity of work can be obtained for the rest of the year to earn the requisite charges, and consequently the excess charges earned in the first six months of the year are lost. Is such a contingency possible? Yes! In a general machine shop there are numbers of machines which cannot always be kept at work, because every order received does not admit of their use; but whether they are at work or standing the establishment charge remains to be earned just the same. Therefore the manager who knows how to organise and run his department will lay himself out to obtain such work as will keep the whole of the machinery at work. He may not get the price he would like for some of it. It may not even be a just price; but if he gets the work at some price he is earning a little more of his standing charges, instead of having his machines idle to fritter away what has already been earned in the previous months.

This prompt action may mean the difference between a loss and a profit at the end of the year.

On the other hand, it is no good trying to do work at competitive prices on old machines. If the tools are out of date, damaged, or unsuitable for the general run of work, get rid of them, and buy some that are suitable. It is by no means uncommon to find tools in use so hopelessly out of date that they could not earn their bare charges if the operator worked for nothing! In most instances the owners have not gone sufficiently deep into establishment charges and shop costs to find it out either.

It may be said, "This is all very well for a machine shop, but how about a foundry?"

The case is much easier.

Given the establishment charges for the year, the monthly total is soon found, and, contrary to most departments, in this one it is quite simple to take a monthly stock, and so know exactly what any month's working has produced.

There is, contrary to what is the case in a machine shop, very little machinery to get out of date, the success of the department depending very largely on the general lay-out and supervision.

If the main bay is served by a good power-driven overhead travelling crane, and the cupola is situated at the end of the same bay, or within reach of the crane, so that the ladle of molten metal can be quickly carried to the mould in any part of the bay, fairly large castings ought to be turned out at competitive prices, and where large castings can be made the melting charges should be correspondingly low. Nothing so hampers a foundry as a quantity of small castings, where the cupola and machinery are laid out for much heavier work. If only small castings are produced the melting charges are high, and the overhead crane is useless. No foundry can make a profit under such conditions.

Orders for large castings should be obtained at cost price if necessary; they would yield—if nothing more—a reduction of the melting charges, and even this is a consideration.

There are cases where a foundry has two cupolas, one large and the other one medium, but where the day's cast is only a little one, one ton, notwithstanding the fact that the entire floor space is occupied by moulding boxes. The castings have been small, they have cost in labour anything up to eight pounds per ton; they will cost three or four times as much per ton in fettling as the larger castings, whilst the supervision will cost the same. How is it proposed to fix the establishment charge on them? Over a given year establishment charges may equal, say, 30s. per ton on an output of 1000 tons, but the average weight of each casting might be 2 cwt. In the instance under review we will assume that the castings weigh ½ lb. each. It is evident that, with an average of ½ lb. against 2 cwt., the same floor space has not yielded anything like the average weight for the day.

Taking the yearly output of 1000 tons, and allowing for holidays, we get an average cast of 4 tons daily. The establishment charges are 30s. per ton; this equals £6 per day. The day's cast of small articles is only one ton; therefore with charges based on a tonnage basis the net charges earned are 30s., which is ridiculous.

It cannot be too strongly laid down that establishment charges which are not based directly upon the labour cost are wrong in principle, wrong in action, and wrong in final results.

We have already had proof that charges based on turnover and tonnage are wrong; let us test charges put on labour in the foundry.

The Average Day's Cast.

	£	s.	d.
Material, *i.e.*, pig iron, scrap, coke, limestone blacking and other sundries, say, 4½ tons	30	16	0
Labour, moulding 4 tons at £2 per ton	8	0	0
Labour, fettling at 2s. 6d.		10	0
Establishment charges, 60 per cent.	5	2	0
	44	8	0

The Small Castings.

Material—2 tons	14	10	0
Labour, moulding 1 ton at £8	8	0	0
Labour, fettling		10	0
Establishment charges, 60 per cent.	5	2	0
	28	2	0

Whilst not claiming that charges based on labour

are perfect, they are certainly more accurate than those reached by any other known method.

The percentage is found by taking the amount of charges to be earned yearly in proportion to the wages bill. By balancing the amounts earned monthly or quarterly the percentage can be raised or lowered as needs dictate.

Any business run on these lines will not have to wait twelve months to find out what its establishment charges are, and whether it has made a profit or a loss.

Here are a few pointers which may not be out of place :—

(1) Your establishment charges are always in inverse ratio to your output.

(2) The machinery your father had in the factory is not any good to you. "The mill will never grind with the water that is passed."

(3) It is no use to trumpet out the fact that your factory has been established a hundred years, or that you made the first steamboat. Nobody cares how long you have been established, and who made the first steamer does not matter. People want to know what you have to sell, what is the price, and how quickly you can produce it.

(4) Standing machinery earns no charges, but leaves on the running machinery its added burden.

(5) Do not be afraid of high wages. Your profits are in exactly the same ratio if you know how to organise your business.

(6) The commercial or trade war with Germany and her Allies will tax all the brains and energy that you can put into your business. A nation so magnificently equipped for war will be equally prepared for a trade war.

GAS-DRIVEN MOTOR VEHICLES.

With the prospect of little improvement in the petrol situation in the near future, it is only natural that very serious endeavours should have been made towards procuring a suitable motor fuel which could be employed as a substitute for the time being. The resources of the gasworks have been accorded the chief share of attention, partly owing to the fact that anything in the nature of a liquid fuel makes running costs almost prohibitive. The gasworks, moreover, are in a position to offer two promising substitutes, the first a solid fuel, coke, applicable, of course, to the heavier commercial vehicles only; secondly, coal gas—or a mixture of coal gas and water gas—which suggests a practicable way of overcoming the present difficulties encompassing the petrol engine. In addition, of course, the majority of gasworks of any pretension are now manufacturing a crude benzol spirit which, if refined, would serve as an admirable fuel; but, for the moment, this product is entirely appropriated for use in connection with explosives.

Little need be said of the growing use of coke in steam-driven vehicles, for the system has for some time now gone beyond the experimental stage, as is instanced by the increasing tendency to employ it as a substitute in all those motors originally designed for consuming steam coal. One of the most interesting examples of the use of coke is that of the omnibuses controlled by the National Steam Car Company, and it is encouraging to note that this company has now a new form of generator which is calculated to eclipse any results which they have obtained in the past. In general, the demand for coke in the direction of motor vehicles is so considerable that a special variety of cut "motor coke" is now turned out by most gas companies.

With all its advantages, however, coke will not further the problem of fuel supply for those cars fitted with the ordinary type of petrol engine, and, whereas the utilisation of coal gas is by no means a novel proposition, it has not really been possible to speak before now with any certainty as to its efficacy for the purpose. Put briefly, it may now be said without fear of contradiction, that the new fuel may certainly be applied with results which are more satisfactory than were looked for so far as the heavier vehicles such as omnibuses, chars-à-bancs, and lorries are concerned, but there is no question that the ordinary private car owner, if he demands the ease which petrol has accustomed him to, will have to wait until further trials have been made. Instances of motor-omnibus services are at the moment far too numerous to receive individual mention here, but it is instructive to refer to one or two of the more notable cases. For instance, a Beeston firm, which was among the pioneers of the movement, has for some months been running a regular service of omnibuses on the East Coast, and over a period extending to nearly twelve months the experience gained is such as to prove that coal gas is a success of the first order, and is, furthermore, more reliable than petrol. The experience of the tramways engineer at Grimsby, where Daimler omnibuses have been adapted for consuming coal gas, is that, as regards pulling power, gas appears to have advantages, although he explains this as probably due to the somewhat inferior petrol now obtainable. The manager of the Scottish Traction Company, after a number of experiments, has decided on coal gas for the omnibuses which connect Edinburgh with the outlying towns some fifteen miles distant, and it is estimated that the new arrangement will enable the full time-table to be maintained, and, owing to the reduction of working costs, the contemplated increase in pre-war fares will not be necessary. Up to the present, services run on the new fuel have been chiefly confined to seaside resorts and north country towns; but so far as London is concerned, mention should be made of the new London–Eastbourne chars-à-bancs which are running twice weekly. These chars-à-bancs are each capable of seating about thirty persons, and they consume no more than 2000 cubic feet of gas for the journey of sixty-five miles. About five stops for re-charging at various gasworks are made en route, and the total cost of the gas for a single journey is in the neighbourhood of 9s., or about 1¾d. per mile.

POWER DEVELOPED.

A well-known firm of motor manufacturers at Coventry, which has for some time been running all its bench tests on coal gas, has been in the habit of using a compressor for supplying the gas so as to obtain the same horse-power from the gaseous fuel as given by petrol. This firm is still experimenting, and has evolved a special carburetter, on the White and Poppe principle, in which gas and air ports are opened simultaneously by the same control. Its experience shows that the horse-power obtained is 85 per cent. of that yielded with petrol, and they have prepared from a large number of trials a series of curves which show at a glance the relative value of the horse-power when using gas. An authority on the new fuel is Mr. W. Clark Jackson, of Neath, where gas-driven tramway cars have been in use for over fifteen years. He has recently stated the results from tests made at Guildford indicate that the petrol engine running on coal gas gives a ratio of its maximum power varying from 84.4 to 87.9 per cent., without any alteration made whatever in design. There is no doubt, however, that with engines designed for a higher compression the power ratio would compare even more closely with petrol. Mr. Jackson has pointed

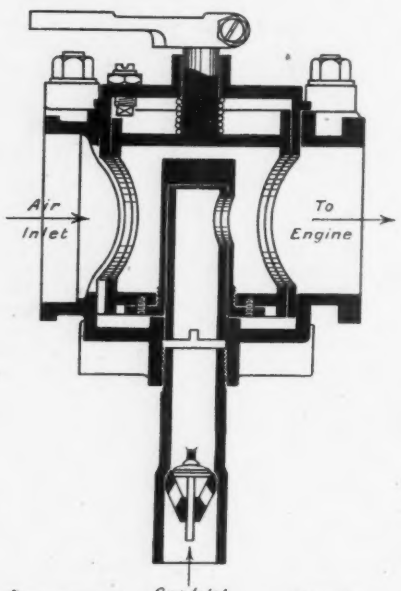


Fig. 1—WHITE AND POPPE TYPE CARBURETTER

out that for all practical purposes petrol can be looked upon as hexane (C_6H_{14}), as it is a mixture of this with the lower and next higher members of the paraffin series of hydrocarbons in proportions which give approximately the composition of hexane. The calorific value of petrol of good normal quality is about 19,000 B.Th.U. per lb., the gas equivalent, therefore, of a gallon of ordinary commercial petrol, assuming the thermal value of modern coal gas as 500 B.Th.U. per cubic foot, is about 273 cubic feet. Thus, after making an average allowance for horse-power losses due to decreased efficiency, the equivalent is approximately 325 cubic feet. Or, in other words, 1000 cubic feet of coal gas or mixed gas are equivalent to slightly more than three gallons of petrol.

As regards comparative running costs of the two fuels the Coventry firm, previously alluded to, has computed that the ratio is five to one in favour of gas, assuming petrol at 2s. 9d. per gallon, and coal gas at 1s. 9½d. per 1000 cubic feet. This, of course, is a somewhat sanguine estimate, for few gasworks are, under prevailing conditions, able to dispose of their main product under about 3s. per 1000 cubic feet, while in the case of isolated provincial concerns the charge may be nearly double this. The Eastbourne–London service, however, provides a very fair illustration, and in this case it is found that the prices vary from 3s. 3d. to 5s. 10d. per 1000 at the various depôts called at, while the average cost works out 4s. 6d. per 1000 cubic feet. Thus for the whole journey gas costs 9s., whereas petrol for the same journey would cost £1. There is as yet a little discrepancy between the various figures given as to costs. For instance, Mr. Shrapnell Smith, of the Commercial Motor Users' Association, has said that 250ft. of gas are equivalent to a gallon of petrol, so that gas at 3s. compares with petrol—the present price of which is from 2s. to 2s. 6d. per gallon—at the almost forgotten price of 9d. Very much, of course, depends upon the quality of the gas; but if the Coventry estimate of a five to one ratio is halved, the newer fuel has still a wide margin to commend it. It may here be mentioned that a perfectly practicable suggestion has been put forward to the effect that coal gas might readily be enriched and made to go further by permitting it to bubble through some form of hydrocarbon oil before passing to the storage vessel on the motor. This is a point which most certainly should receive further consideration, although the drawback lies in the fact that anything of a liquid fuel nature is at the present time extremely costly, and it might—when recharging facilities are plentiful—be preferable to use the unadulterated gas.

THE NECESSARY ADJUSTMENTS.

It has been shown above that the petrol engine may be employed with gas without any structural alterations whatever, but it seems certain that better results may be obtained if slight modifications are carried out. As an instance of the interchangeability of the two fuels, however, it may be pointed out that in the case of the Beeston firm an emergency supply

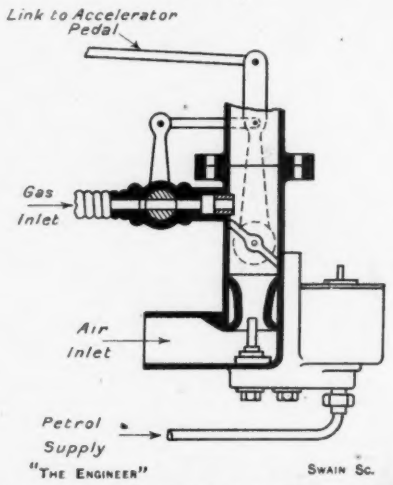


Fig. 2—BEESTON DUAL DEVICE FOR PETROL OR GAS

of petrol is usually carried. Should the gas give out on the road, and any impending shortage is readily noticeable from the behaviour of the engine, the petrol supply is immediately turned on and allowed to run to the carburetter without any necessity for the driver to stop the vehicle or leave his seat. The White and Poppe carburetter, as designed for use with the coal gas, is shown in Fig. 1. The gas and air ports and the throttle are formed in cylindrical sleeves, and are all operated from a single control lever. The size of the ports and the relative opening of each are specially designed to suit the particular quality of gas employed, while a non-return valve to exclude waste products is fitted in the gas inlet. The Beeston dual device for petrol or gas, on the other hand, is illustrated in Fig. 2. In this case the ordinary air inlets hold good, while a single link lever connected to the accelerator controls both the movement of the gas cock and the butterfly throttle valve. No non-return valve is inserted. On the Neath tramways, where, by the way, the engines are of an old-fashioned horizontal type, a special diaphragm valve—Fig. 3—is employed in order to obtain the

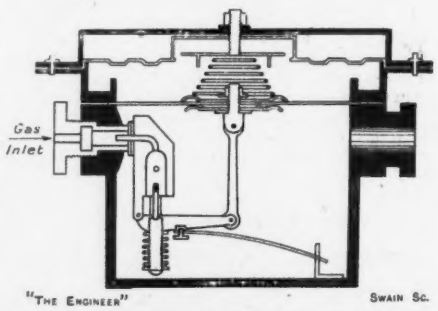


Fig. 3—DIAPHRAGM VALVE, NEATH TRAMWAYS

necessary reduction of pressure between the storage receivers and the engine. At Neath, it should be pointed out, the gas is stored under pressure in cylinders, a provision which has its advantages, but which has recently been shown to be quite unnecessary. The reducing valve consists of a leather diaphragm which rises when the pressure exceeds the stated amount and falls when a deficient pressure is given. This action closes or opens, respectively, a throttle valve on the gas inlet connection. The gas enters the valve chamber as shown, the chamber itself being of sufficient capacity to hold half a cubic foot of gas, and the centre of the diaphragm is coupled by a link motion to the throttle valve on the inlet

pipe. If the gas pressure rises above the desired amount the diaphragm lifts and closes the throttle, and *vice versâ*. The object of the spring seen on the upper surface of the diaphragm is that of pressure adjustment, while the flat spring in the base of the chamber tends always to keep the valve closed.

STORAGE PROBLEMS.

The convenience with which petrol is employed has to a considerable degree prejudiced the use of coal gas, for in strenuous times such as the present, no one has much inclination towards adopting a system which is certainly going to give a little more trouble. In fact, if it were not for the inherent difficulties associated with the storage of gas its employment would have developed long before this, and there would have been no need for such circumstances as the present to bring the matter to a head.

Briefly speaking, the manner of storing the gas has developed upon two lines. First, that of employing flexible containers, which are charged and operated at normal gasworks pressure; and secondly, the utilisation of pressure containers, which necessitate special compressing plant for their filling, and with which it is essential to employ some form of pressure regulating valve as shown in Fig. 3.

So far as can be gathered at present it would seem that the advantage of longer runs without recharging associated with the pressure system is more than counterbalanced by the capability of the flexible holder to take up a fresh supply at any gasworks, irrespective of special compressing facilities. A factor of primary consideration, moreover, is the weight of the storage apparatus, and it is essential that the vessel should be of such character and design as will superimpose no great additional weight on the vehicle, while at the same time it must occupy the minimum amount of space. Mr. Clark Jackson, for instance, has pointed out that the addition of one ton deadweight, which is an outside figure, to a three-ton to five-ton lorry, entails an additional running cost of approximately 1d. per mile.

In the case of the Beeston omnibuses the container takes the form of a light flexible bag or collapsible holder firmly strapped to the roof of the omnibus, and while the vehicles themselves weigh about 3½ tons, the car load at times reaches a figure of 9 tons. Under these conditions the consumption of gas approximates to 350 cubic feet per twelve mile run, although, with special care and a proficient driver, an omnibus with a car load averaging 7 tons has managed an eighteen mile journey with a consumption of gas amounting to only 370 cubic feet. The cost of the flexible holder is comparatively trivial, one of moderately large capacity running into about £20. In the case of the Daimler omnibuses previously mentioned, the bag consists of a simple sack of canvas, which is covered with rubber insertion to render it gas-tight and waterproof, the outlet to the engine being composed of a flexible tube.

With regard to motor lorries as distinct from omnibuses, the question is a little more aggravated, for in such cases the use of a flexible gas-bag is practically out of the question. In these instances it is contended that the only reasonable method is that of storing the gas in receivers under a pressure approximating to 150 lb. per square inch or upwards. Such a system has been in use at Neath since the commencement. Again, there is some divergency of opinion as to the most suitable position in which to carry the reservoirs. Some prefer to fix the vessels beneath the back axle, while others carry them on the floor of the lorry and cover them with a false flooring, upon which the goods may be stacked. Mr. Jackson's suggestion is that a battery of receivers could best be constructed from high-grade steel piping of 8in. to 10in. diameter, the tubes being connected together at one end by couplings, with an outlet from these to the engine. This method would possess the merit of confining the weight within reasonable limits, and with such a battery made up from four 10ft. lengths of pipe, it would be comparatively easy to store about 300 cubic feet of gas at a pressure of 300 lb. per square inch. A more recent suggestion is that of employing a receiver in the form of a motor tire, with an inner and outer cover, but made in cylindrical form. In this way it is said that a cylinder of 7ft. in length and 15in. in diameter will stand an internal pressure of 250 lb. per square inch, and be capable of storing 250 cubic feet of gas, while the total weight would only be some 50 lb.

In practice, it seems that coal gas will show appreciable economy as compared with petrol, owing to the fact that with the petrol engine a considerable amount of loss takes place when the power is frequently varying from no load to maximum load. Under such conditions there is always the difficulty of maintaining a correct admixture of air and petrol. Thus the objectionable products which are expelled from the petrol engine under certain conditions of running should be entirely avoided when gas is employed as the motive fuel. This arises from the fact that it is a comparatively easy matter to regulate mixtures of coal gas and air, to comply with the varying load conditions. Another point, too, is the comparative ease with which the petrol engine will start up on coal gas. In fact, the advantages of gas over petrol in this direction are such that in many cases the large garages now have a flexible pipe laid on to the gas service in order to prevent any delay in getting going.

FUTURE PROSPECTS.

It is necessary to emphasise the fact that although the gas companies of the kingdom are now doing all that is within their power to assist the owners of motor vehicles, they have no thought of making an endeavour to capture the business of the petrol purveyor. Even though gas at normal prices compares with petrol at about 8d. per gallon, it is realised that convenience is worth a good deal to the motorist, and when once the war is over there may be very little demand for the more unconvential fuel. It is for this reason that gas companies are in no hurry to lay down any plant in the way of affording special compressing facilities when there is a possibility of there being little use for such plant in the time to come. At the moment, too, the demand for gas, occasioned by its extended use in industrial directions, and in lieu of coal in the domestic grate, is such that the majority of the concerns have their hands pretty well full, and have no desire for very much in the way of new business. In pre-war times the quantity of petrol imported into the country was approximately 120 million gallons per annum, and it has been estimated that at the moment an amount of petrol equivalent to about half-a-million gallons per annum has been replaced by gas; although, of course, the figure is increasing every day. The gasworks, however, no doubt realise that they are in a position to provide solid, liquid, and gaseous fuels for road vehicles, and, while the solid fuel, coke, seems to be looking after its own interests, and making steady headway, the opportunity with the petrol engine will come in the future when the large quantities of light spirit now extracted for use in the manufacture of explosives are no longer required for that purpose to the same extent.

LANGSTONE HARBOUR SCHEME.

Portsmouth has for a long period nursed ambitions to create on the Langstone Harbour site, which is situated in close proximity to the eastern boundaries of the town, a first-class commercial port. A report on such a scheme, dealing with the project from the engineering standpoint, was made some years ago by the firm of Sir John Wolfe Barry and Partners for the Portsmouth Chamber of Commerce, and although no definite action has yet been taken the developments outlined in that report constitute the basis of the proposal to which so much publicity has been given recently. The reasons for bringing forward the proposal at this juncture are based on the belief that it will be necessary in the new commercial era to provide additional port and dock facilities for ocean trade on the South Coast, where, with the conspicuous exception of Southampton, there is no first-class port. Portsmouth and Plymouth have been almost entirely reserved for Admiralty use, and although Dover has been made a port of call for ocean liners, the commercial trade is confined, like that of Folkestone and Newhaven, almost entirely to vessels engaged in the cross-Channel and near continental services. Nor has any but limited use been made of Falmouth by merchant vessels. In any case, whatever developments may be made elsewhere, it is considered that the situation of Portsmouth, both from the point of view of nearness to the ocean trade routes and railway transport, makes out a strong case for the provision at Langstone of dock facilities capable of receiving the largest class of vessels now afloat or in contemplation. The Corporation of Portsmouth, local traders and shippers, and, it is stated, important railway and shipowning interests, are taking an active interest in the subject, and, indeed, a stage has been reached when consideration is being given to the financial aspect and the method of providing the capital for the first section of the works, which are estimated to require an expenditure in round figures of at least £2,000,000. The alternative schemes are a dock company in which important railway and shipping interests, as well as the Corporation, might be represented, and a harbour trust in which it would be hoped to interest the overseas Dominions, for the expansion of whose trade with the Mother Country the new docks would be mainly provided. No construction work can be put in hand until after the war, but it is felt that the obtaining of the necessary parliamentary sanction, and other initial steps, might now be undertaken with advantage. Under these circumstances a brief account of the engineering aspect of the scheme will be of interest.

At the present time Langstone Harbour, which at high water has a total area of over 4000 acres, is only accessible near the time of high spring tide, and even then it is unsafe for vessels to enter the harbour drawing more than 13ft., the maximum depth of water on the bar being 16½ft., which gives only 3ft. at low water springs. The material composing the bar is sandy shingle, superimposed on clay, and while little change has taken place in the position of the bar over a long period there is evidence, derived from a comparison of Admiralty charts extending back to the year 1783, that the depth of water on the bar is tending to increase. Mr. E. Crutwell, who was closely associated with the preparation of the report made by Sir John Wolfe Barry's firm, recently stated at a meeting held in Portsmouth that he believed the depth of water on the bar would continue to increase, and there would be very little difficulty in keeping the entrance channel clear of shingle. The report, to which reference is made, proposed the dredging of an entrance channel through the bar not less than 600ft. in width, with a maximum depth of 25½ft. There is, however, a feeling on the part of local interests that not only in the approach channel but elsewhere there should be a depth of 35ft., so that the large ships which it is hoped would be attracted to the port could enter the dock system at any time. The harbour works, as detailed in the report, would include, as a first step, the construction along the Portsmouth side of the harbour of a tidal quay extending north and south for a distance of 3900ft. This quay would be constructed as a solid concrete wall, use being made for this purpose of the shingle dredged from the entrance channel, the depth of water alongside the quay to be the same as that in the entrance channel. A short length of new railway would connect the quay and the dock system generally with the joint line of the London and Brighton and South-Western Railways, and as the quay and the wet docks would be situated on what is now the foreshore of the harbour or the existing water area, there would be an ample area of land available for the anticipated extension of Portsmouth in this direction. A new eastern main road, which is in contemplation, would give transport facilities in the Langstone area.

The dock system would be constructed on the foreshore to the westward of the tidal quay. An entrance lock, 650ft. long, 80ft. wide, and with 29½ft. of water on the sills at high spring tides, was originally proposed, but, in view of recent developments at Newport and at Avonmouth, the dimensions of the entrance lock would, it is believed, be increased. The main basin shown on the plans accompanying the report measures 1300ft. from north to south, with an average width of about 1360ft. from east to west, giving a water area of about 40 acres, and having three connecting arms each of about 10 acres area, making a total of 70 acres, and providing about 12,250ft. of quay wall. A timber pond, having a water area of about 18 acres, is shown adjoining the east arm of the dock and connected with it by a passage. As it would be necessary, in order to enclose the site of the dock, to form an embankment to the west, part of this, for a length of about 2500ft., might be used as a tidal quay by the construction of a number of short jetties, and, for the purpose of keeping the berths at this quay free of silt, the low water channel of Milton Lake, the present course of which is through the site of the main dock, could be diverted alongside the foot of the embankment. Provision is also made in the report for a graving dock, to be constructed on a site alongside the entrance lock, and to be of the same dimensions as the latter. The graving dock would be entered from the main basin. The material over the whole of the site is mainly stiff clay with no indication of running sand.

These are the main features of the one scheme which has received consideration from the engineering standpoint, and the only change in the attitude of the local authorities since this report was made is in the direction of enlarging the scope of the proposed undertaking in the light of the most recent developments.

THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

The Report for the year ending 31st July, 1917, of the Committee of the Privy Council for Scientific and Industrial Research, has just been published. It is an exceedingly interesting document, and we cordially commend its perusal *in extenso* to our readers. For the convenience, however, of those who are unable to do this we propose in this and the following issues to give extracts from it.

As was the case last year the bulk of the Report is taken up by an account of the doings of the Advisory Council. In the Report of the Main Committee it is explained that on 1st December last Lord Crewe, the Lord President of the Council, announced to a deputation from the Board of Scientific Societies that the work of the Committee of Council for Scientific and Industrial Research with that of their Advisory Council, first instituted for reasons of convenience under the ægis of the Board of Education, had been established as a separate department with offices in Great George-street. As the work of the Advisory Council developed and the industrial side of research grew in bulk and importance, it became clear that a separate organisation having its own estimates in charge of a Minister responsible to Parliament was a necessity. The foundation of the new department led to the creation of the Imperial Trust for the Encouragement of Scientific and Industrial Research. The Charter empowers the Lord President and six other high officers of State to hold funds, to enter into contracts and agreements, and to do other things in furtherance of the objects of the Committee of Council for Scientific and Industrial Research. A donation of £1000 made by Messrs. R. H. and R. Williamson to be expended as to half its amount on research into some subject of mechanical engineering in conjunction with the Institution of Mechanical Engineers and as to the other half on such research as the Committee of Council may determine, has been deposited with the Trust as well as a sum of

£13 14s. 9d., representing the turnover on the Treasury Bill, which was drawn for the donation.

"It is also intended," continues the Report, "that the Trust shall hold on behalf of the Department the sum of one million sterling which Parliament has voted for the purposes of the Department. The negotiations of our Advisory Council with the leading manufacturers in the various industries have shown that it would not be possible to develop systematic research on a large scale unless the Government were in a position to assist financially over an agreed period of years. The industries, and especially the great staple industries, might be expected to bear a considerable share of the large sums involved; but on the one hand it would be difficult if not impossible to foresee from year to year the amount of expenditure likely to be called for, and on the other, the industries would not unreasonably look for an assurance that, as the need arose, the Department would be in the position to give the necessary aid. Further, we were advised that at any rate the larger and more prosperous industries might be expected, after an initial impetus, to find themselves both willing and able to continue the work of research without direct assistance from the State. These three considerations convinced the Government that the somewhat novel expedient of placing a fund at our disposal to be spent over a period of five or six years, afforded the best means of dealing with the problem. This fund, amounting to a million pounds, will be deposited with the Imperial Trust and expended in accordance with our directions. Our Advisory Council have recommended that the money thus made available should be spent in the form of grants in aid of research undertaken by firms in any industry which may combine to conduct it on a co-operative basis. The Council advise us that the best means to this end is the establishment under the Companies' Acts of Associations for Research limited by guarantee and trading without profit. We have approved this method of procedure, which has the additional advantage that the Board of Inland Revenue have decided, with the approval of the Chancellor of the Exchequer, that no objection shall be offered by their Surveyor of Taxes to the admission, as a working expense for Income Tax allowance, of contributions by Traders to Industrial Associations under Government supervision which may be formed for the sole purpose of scientific research for the benefit of the various trades; and that the allowance would be equally applicable to traders' contributions specifically earmarked for the sole purpose of the Research Section of an adapted existing Association."

During the past year negotiations have been concluded with the Royal Society for the transfer of the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, to the Department. The scientific management of the Laboratory will remain in the hands of the Executive Committee under the chairmanship of Lord Rayleigh, a member of our Advisory Council. The Executive Committee will be appointed as heretofore, but on its appointment it will become a Committee of this Department, which will report to the Research Committee through its Advisory Council in the same manner as all other Committees of the Department. It is believed that this change, while relieving the Royal Society of a heavy financial responsibility, will ensure its continued interest in and care for the important scientific work entrusted to the Laboratory in growing measure from year to year. It is also believed that its nearer association with a Department that is coming daily into contact with industry will help to bring fundamental research into closer and more continuous relation with the investigations into processes and products which must occupy so large a part of the attention of the works research laboratory.

In order to deal effectively and systematically with the urgent problem of fuel economy, a Fuel Research Board, with Sir George Beilby as Director, has been appointed. Sir George Beilby, with marked public spirit, has accepted the post of Director, which, at his own request, will be without remuneration. The other members of the Board, who are also unpaid in this capacity, are:—The Hon. Sir Charles A. Parsons, K.C.B., F.R.S., Sir Richard Redmayne, K.C.B., Mr. R. Threlfall, F.R.S. The Board will report through the Advisory Council, but it is intended that it shall have executive powers of its own within the limits of an annual approved budget. The Fuel Research Board has recently appointed an Irish Committee of Inquiry into Peat as a source of power. The Committee will meet in Dublin under the chairmanship of Sir John Griffith.

Because of its great national importance, the Committee makes special reference to a grant of £1000 a year for five years, together with a grant of £750 for special apparatus, which, on the recommendation of its Advisory Council, it has made to the Department of Technical Optics recently established at the Imperial College of Science and Technology. The College is providing laboratory accommodation and an equipment grant of £2000. The Committee's grant will be devoted entirely to research purposes, but the new Department is also receiving generous support for both its research and educational work from the Board of Education, the London County Council, and the optical industry.

The Committee has also considered and approved recommendations in respect of aid to forty-four scientific investigations of industrial importance. Nine of these had already received aid during the financial year 1915–16; the remaining thirty-five were new proposals. Throughout, the work of the Committee has suffered in amount owing to the war, and not more than £14,524 out of the £40,000 placed at its disposal by Parliament for the financial year 1916–17 could be spent by the Committee. During the current year it has taken a sum of £38,050 in its estimates in addition to the fund of a million which has been referred to above. The annual vote is intended to cover (*a*) the cost of those researches which will not be undertaken by the proposed Research Associations; (*b*) the grants to individual research workers, both students and others; and (*c*) the cost of administration.

REPORT OF THE ADVISORY COUNCIL.

In our report of last year, covering the period from 28th July, 1915, to 31st July, 1916, we attempted to describe the nature of the problems by which we were faced, and the conditions which appeared to us necessary for their solution. . . . The experience of another year of work has confirmed our first estimate of the position. We have made progress. The establishment in December last of a separate Department of State entrusted with the organisation of scientific and industrial research has brought encouragement to our efforts and the necessary financial support. But the progress must be slow for the calls of war continually grow, and the numbers available for other work, however important, continually shrink. In a sense it is fortunate that we have escaped the temptation to hurried action. "We may think of scientific research," says Professor Bragg, "as an army advancing into an unknown country, in which it is not possible to see more than a step or two ahead."† The provisioning of such an army calls for circumspection and a great deal of detailed work. Some estimate of its amount can be formed when it is stated that during the past year we have held nineteen meetings as compared with thirteen in our first year of work, while the Applications Committee, appointed as recently as February of this year, has held nine meetings. In addition our various Standing Committees have met in all nine times, while their Sub-committees and Sections have held fifty-two meetings. We have also had the assistance of twenty-eight Special Committees in dealing with applications for grants-in-aid. It is impossible to give statistics of the meetings of the many Committees engaged in the actual direction of the researches being conducted by or with aid from the Department.

We have addressed ourselves during this year in the main to the organisation of industrial research, first, because we felt the paramount importance of arousing and securing the interest of manufacturers in the application of science to industry, and secondly because the influence of the war has created in industry an atmosphere conducive to the growth of new ideas, whereas it has unfortunately made the prosecution of work in pure science and in its organisation a matter of extreme difficulty. Sir Joseph Thomson urged at the deputation to the Lord President referred to below that "pure science is the seed of applied science and . . . to neglect pure science in a thing of this kind would be like spending a very large amount of manuring and ploughing the land and then to omit the sowing of any seed." We accept the analogy, and we trust that the absence of extended reference to pure science in this report will not be taken as indicating our lack of appreciation of its importance.

In Part I. of this report we describe the steps we have been able to take during the past year to organise a systematic approach to the problem of industrial research, on a co-operative basis wherever this method of finance is practicable, and by the Department itself in those important fields of work which call for independent State action. We then proceed to discuss the necessary part played by surveys in the work of research and the limits within which the responsibility for them should rest with the Department. In the succeeding paragraphs we refer to recent Departmental publications, to the appointment of new Standing Committees and of new Assessors, and to the development of Research organisations in the Dominions beyond the seas.

In Part II. we briefly describe the progress made in a number of sporadic investigations aided by the Department since its establishment, or initiated during the past year. We next give an account of the grants made under a scheme approved by the Committee of Council to individual research workers. It will be noticed that under this head no distinction is, or indeed can be, made between pure and applied science. As we have already said, the Council are as deeply concerned in the encouragement and training of research workers in pure science as of those in technology. We hope indeed that after the war the number of both will be greatly increased. In the concluding paragraphs of the report we deal with the interesting questions of the best means of encouraging inventors and aiding individual manufacturers.

PART I.

The Million Fund for Trade Research Associations.

The one question of policy, to which throughout the year we have continuously devoted our attention, is the working out, with all the care and advice we have been able to command, of the policy of co-operative industrial research foreshadowed in our last report. We have approached this problem with deliberation because it is too difficult and complicated a matter to allow of rapid action. Association and combination are "in the air," and many trade associations have come into existence during the past year, some of which include research among their objects. But while we welcome this evidence of the growth of a spirit we have ensued, it does not seem likely that most of the new or previously existing associations will be qualified to avail themselves of the full benefits that the Government is prepared to offer. On the other hand, we see no difficulty in the establishment of associations, which would conform to the necessary conditions, in connection with, or independently of existing corporations. Lord Crewe, who was at that time Lord President of the Privy Council, received a deputation of the Board of Scientific Societies on the 1st December last, at which he outlined the policy of the Government in regard to industrial research. He announced their intention to ask Parliament to place a large fund—a million sterling—at the disposal of the Department to enable it to co-operate with the industries of the country in the foundation and maintenance of approved Associations for Research during the next five years or so. After these initial years it is expected that the larger industries, at any rate, will be able and willing to carry on the work of the Associations without assistance. The intention of the Government is to make a contribution to the assured income of such associations from the subscriptions of their members, varying in amount according to circumstances, and with a normal maximum of pound for pound, though in very exceptional cases this limit may be exceeded. Lord Crewe also announced that the Board of Inland Revenue would be prepared to instruct Surveyors of Taxes to allow as a working expense for income-tax purposes the contributions by traders to industrial associations formed for the purpose of scientific research for the benefit of the various trades. The allowance would be subject to certain conditions; that is to say, the Association must be under Government supervision and the trader's contribution must be "an out and out payment, made from his trade profits and giving him no proprietary interest in the property of the Association." Since this decision includes War Profits and Excess Profits taxes, it offers a considerable inducement to firms affected by these taxes to act promptly.

Model Memorandum and Articles of Association.

These were the conditions of the Government offer, and we proceeded to draft a model Memorandum of Association for companies limited by guarantee of nominal amount and working without profit, such as would fulfil the purposes we had in view, and at the same time be registered by the Board of Trade under the Companies' Acts without the use of the word "Limited." We have also prepared notes for the guidance of those desiring to draft the Articles of an Association for Research and a short statement of the conditions under which the Department would make grants to such an association when founded. Further, the Department has issued a brief descriptive leaflet on "The Government Scheme for Industrial Research," which explains in non-technical language the manner in which the associations are expected to work. These three documents are reprinted in Appendix III. It is not an easy matter at the best to establish associations under Government auspices for so novel a purpose. The form had to be sufficiently flexible to suit the widely different circumstances of a multitude of industries, and to be conformable as well to the existing law as to a reasonably simple system of Government aid. It would have been impossible to devise the necessary machinery without the active and patient assistance of a large number of leading manufacturers and business men who have given us their advice and criticism and have treated our appeal to them as confidential. We desire to take this opportunity of thanking them individually and collectively for their help, and to assure them and the industries of our welcome to any criticism or suggestion for improvement they may be able to offer now that the documents are published.

The Representation of Labour.

As regards the constitution of the Governing Body or Council of an association for research, it is obvious that capital, management, and science must have suitable representation. But we believe further that greater success and a wider scope of action will be attained if provision is made also for the inclusion of labour. In most cases only skilled labour will be concerned. We think it important, however, that the workers in an industry should be able to ascertain at first hand how science is applied to industry and how funds devoted to this purpose are expended, and that they should also be able to urge the importance of research which would result not so much in pecuniary gain as in the increased health and comfort of the workers. We were accordingly much interested to read the proposals contained in the Interim Report just issued by the Sub-Committee of the Reconstruction Committee on Relations between Employers and Employed [Cd. 8606], which advocates the establishment of Standing Joint Industrial Councils. We believe that Councils so constituted as to be able to discuss with knowledge questions affecting both employees and employed would, if they could be brought to work successfully, greatly help the formation and development of Trade Research Associations. We notice that it is proposed that the National Councils should be empowered to allocate to District Councils the following among other questions:—

"Industrial research and the full utilisation of its results; the provision of facilities for the full consideration and utilisation of inventions and improvements designed by workpeople, and for the adequate safeguarding of the rights of the designers of such improvements.

"Improvements of processes, machinery and organisation and appropriate questions relating to management and the examination of industrial experiments, with special reference to co-operation in carrying new ideas into effect and full consideration of the workpeople's point of view in relation to them." We think it valuable that any National Councils which may be established should have these powers of decentralisation, for unless each locality is carried along in the forward move we cannot hope for any steady advance. But we hope they will also retain these questions in their own hands, since it is to be anticipated that the Trade Research Associations will, as a rule, be national rather than local in character.

(To be continued.)

† Loc. cit., page 25.

In order that the fruit which railway companies are unable to carry, owing to traffic exigencies, shall not be wasted, the Food Production Department is establishing works at all fruit centres, where fruit so held back will be pulped or dried.

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. IV.*

QUITE an interesting proposal is outlined in the specification of the patent of John Walker, of Castlecomer, in county Kilkenny, which is numbered 19,150 of 1895, as will be realised by an examination of Fig. 23. Practically no description is necessary. There were two endless bands of links, C, embracing two sets of pulleys B, one set at either side of the vehicle. These pulleys were so arranged that they did not come in contact with the ground. Then there was another pair of wheels A, arranged between the two pairs first mentioned. These wheels carried the weight of the vehicle and rolled on the inside of the bands or rails. A cross section at the joint between two of the rails, and showing also the rim of the wheel bearing on the rail, is shown in Fig. 24.

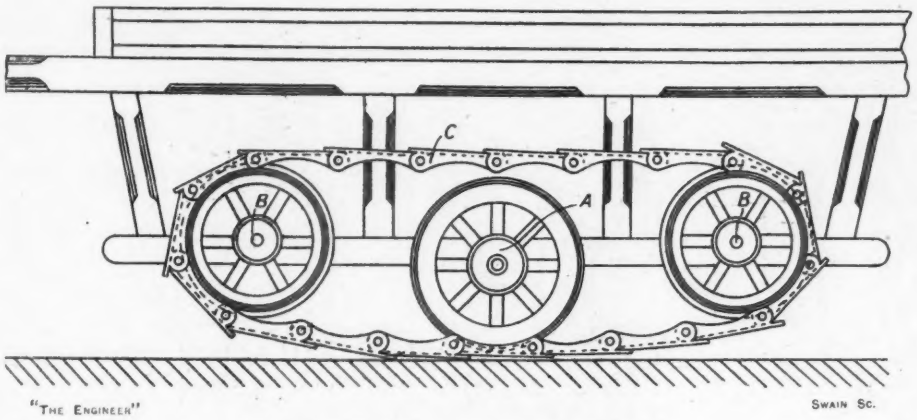


Fig. 23—SKETCH SHOWING WALKER'S PROPOSAL, 1895

The next specification calling for mention is that of the American, R. S. Angell, No. 571,326 of 1896. It describes a peculiar arrangement, as may be seen from Fig. 25, which shows it diagrammatically, and has been enlarged from a very small view given in the abridgment of the United States patent. We have not had the full specification before us, and are, therefore, unable to give a complete description of the mechanism, but, apparently, there were two endless bands of balls connected together by chain links, these bands passing over two pairs of grooved pulleys, one pair at each side of the vehicle. There was provision, as will be observed, for taking some of the weight of the vehicle on the balls between the two pairs of wheels.

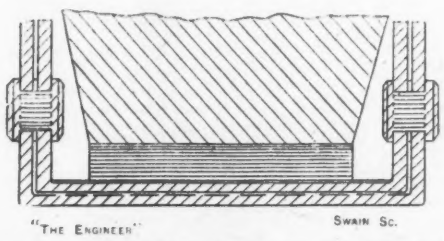


Fig. 24—SECTION OF WALKER WHEEL-RIM AND CHAIN-TRACK

Patent No. 12,447 of 1897 was taken out in the name of P. R. J. Willis, the subject matter having been communicated to him by the inventors, James Allen Justice and Peter Johnson, both of Macey, Arkansas, the title being "Improvements relating to vehicles." The drawings, accompanying the specification, show the suggested improvements applied only to a horse-drawn vehicle. However, both the provisional and complete specifications speak of "improvements in traction wheels" and "traction engines," though the inventors do not explain in what way motion is to be transmitted to the endless chains, nor say what is to prevent the wheels slipping if power is applied to them and not to the chains. A vehicle equipped according to the invention is shown in Fig. 26; a particular form of vehicle, fitted with the Justice-Johnson tracks, is shown in Fig. 27, while views of the track are given in Fig. 28. The track is made up of two sets of links—an outer and an inner set. The outer links A have flanges B. The tread of these outer links may be of any desired width. The inner links C also have flanges D, which are made convex on their adjacent faces, as shown in the engravings. Between these convex faces the rims of the wheels fit fairly closely, and it is claimed that the making of the flanges convex renders it easier for the wheel to work in the channel. The inner links are furnished on their outer sides with split projections E, which are intended to pass through openings in the outer flanges, and then to be spread like split pins so that outer and inner links are fastened together. The inventors do not explain how this arrangement is to be carried out in practice, and it is difficult to understand how the construction could be effected unless the flanges of the outer links were actually bent up, so as to embrace the inner links *in situ*, and unless the holes in the outer links were a good deal bigger than the projections on the inner links. Arranged to work in the channel between the convex surfaces of the inner links is a brake shoe F, which is pivoted to the framework of the vehicle at G, and is connected by the rod H to the lever J by the driver's seat, which is provided with a ratchet L and pawl K. This brake shoe, besides controlling the speed of the vehicle, is intended to plough out any mud, gravel, or other substance which may find its way into the channel in the inner chain. The sections of the outer chain are connected together by links in such a way that a flexible track is formed.

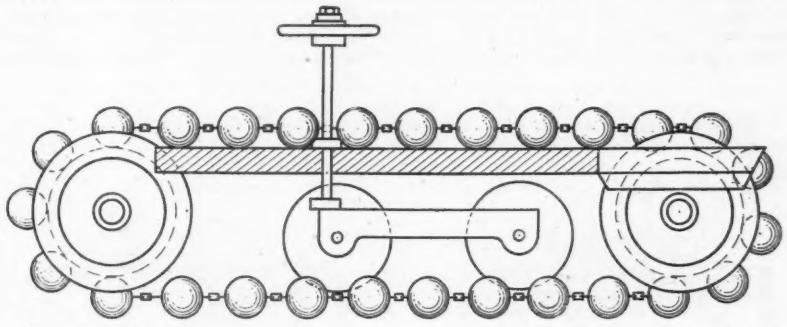


Fig. 25—SKETCH SHOWING ANGELL'S PROPOSAL, 1896

The particular construction of vehicle frame, shown in Fig. 27, has for its object that the vehicle may be turned without slackening or tightening either chain. To bring this about the front cross bars M, M^1 are pivoted at their centres N, N^1 to the draught bar O, and are pivoted at their ends to the bars P and Q. Cross bars R, R^1 are pivoted at their front ends at the points P^1, Q^1, and at their rear ends S^1, S^2 to the ends of the bar S, which is connected to the two ends T^1, T^2 of the bar T by two links U, U^1. The bars M and T are supported from the bolster, and receive the axles, as the inventor says, "in any suitable manner." It is not clear how the chain track is made to be flexible sideways, so as to permit of the bending which must take place when the wheels are moved in the manner shown in the engraving.

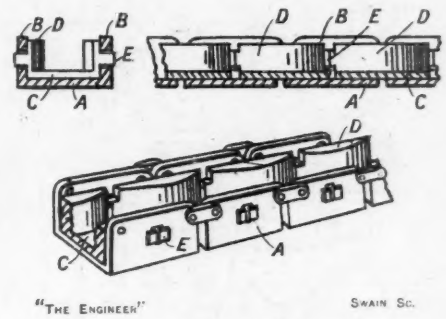
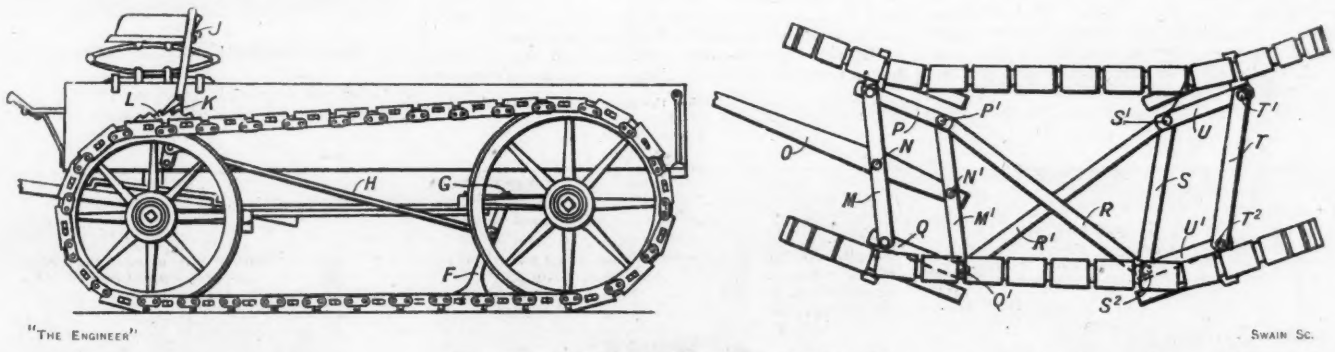


Fig. 28—THE JUSTICE-JOHNSON CHAIN TRACK

The first patent for the Pedrail Tractor of Mr. B. J. Diplock was No. 14,710, of 1899, and it embodied some peculiar and interesting pieces of mechanism. Diagrammatically, the arrangement is shown in Figs. 29 and 30. The driving wheels were formed of a series of feet which reminded the observer irresistibly of those of the elephant. The general working may be described as follows. In Fig. 29, A is a steel disc keyed or fastened in some other manner to the driving axle. Mounted in the disc and arranged so that by means of springs—not shown in the drawings—they are continuously pressed radially inwards in their guides towards the axle is a series of sliding rods These act as spokes, and each of them is fitted at its outer end with a foot B, pivoted by a ball and socket joint, so that it can turn to any reasonable angle to suit the surface of the road. Fixed to one side of each spoke, and projecting beyond the disc A is a wheel or roller C. Depending from and rigidly attached to the axle-box I is a flat plate or guide E, to which is pivoted a rail D. The pivot of the rail is free to move up and down in a slot in this plate. The rail D supports the vehicle by two springs G, the upper end of which press against a top lever H, which, in its turn, is pivoted to the top of the axle-box I. Two further springs J are fitted to serve to steady the lever H. The two guides K are provided to lead the rollers C under the rail D.



Figs. 26 and 27—THE JUSTICE-JOHNSON PROPOSALS, 1896

The disc A, with the spokes, rollers and feet revolve; but the axle-box, and its dependent lever, guides, rail, and springs, do not revolve. The result

* No. III. appeared August 24th.

is that as each wheel comes into contact with and passes down the face of one of the guides K, the wheel, and with it the spoke, and foot attached to it, supporting the load, is *levered* along by the spokes over the rollers. In the ordinary railway a rail is laid down and wheels run over it; in the Pedrail, wheels or with the ground, in Fig. 29, is lifted up before the corresponding foot at the other end of the rail comes down. Each wheel of the vehicle had, therefore,

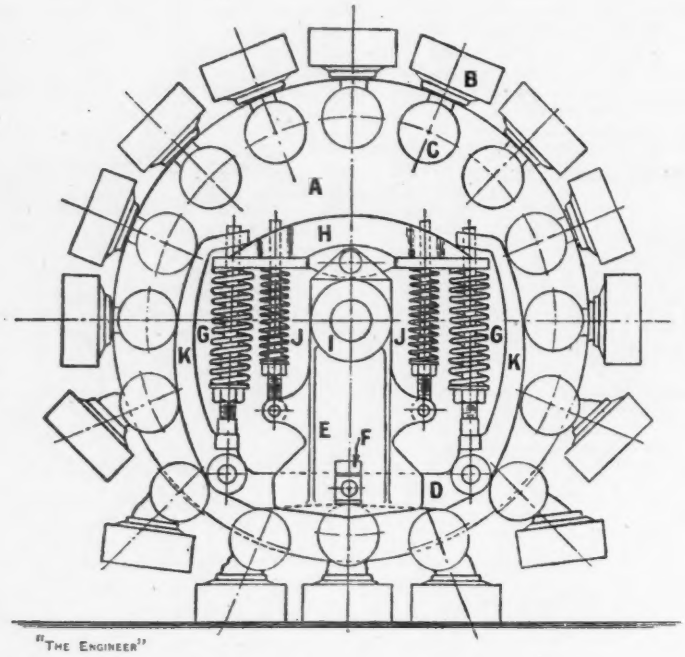


Fig. 29—DIPLOCK'S PEDRAIL WHEEL, 1899

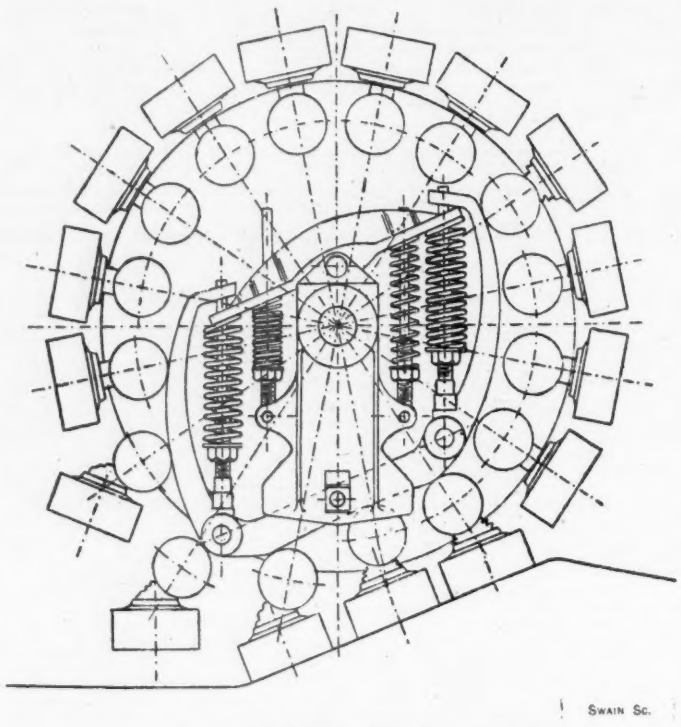
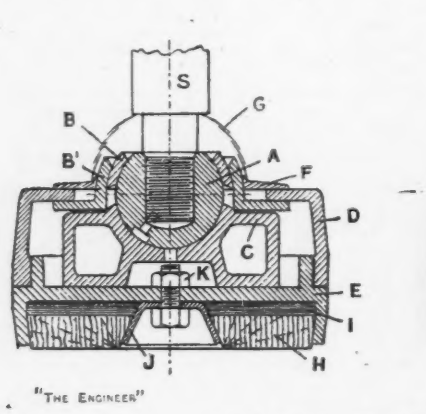


Fig. 30—THE PEDRAIL CLIMBING AN INCLINE

are forced outwards, which permits the foot to turn on its ball joint—designed to take the place of an ankle—as it comes down, the result being that it finally drops with its flat surface on the road and the roller passes under the rail. The underside of the rail is slightly arched, as will be observed, this form being given to it so that the varying height of the rollers caused by the spokes being sloping or upright may be neutralised, and that the feet may present a uniform level surface to the road.

Mr. Diplock, in his book, entitled "A New System of Heavy Goods Transport," which was published by Longmans, Green and Co. in 1902, and from which the sketches accompanying this description have been reproduced, explains the action as follows:—"Practically the Pedrail system places feet on the ground, each supporting a roller or edge, and a short rail, rollers are laid down and the rail is run over them. The principle is the same, only the railway is inverted. The sliding spoke represents the horse's leg, or lever, and each leg is pivoted by an ankle joint to its foot. By turning the railway upside down, the parts coming in contact with the road are broken up into a number of comparatively small feet, which can twist in *varying* directions as required. Previous attempts at endless railways have failed owing to the attempt to place the *rail* next the ground.* The rail, presenting a *long* cumbersome surface to the road, did not lend or adapt itself to the varying inequalities of the road surface, and hence caused endless breakages and repairs."

The arrangement was such that as the Pedrail moved forward one of the three feet shown in contact alternately, two and three feet on the ground. Mr. Diplock remarks that if a four-wheeled traction engine of his design such as that which was tested,



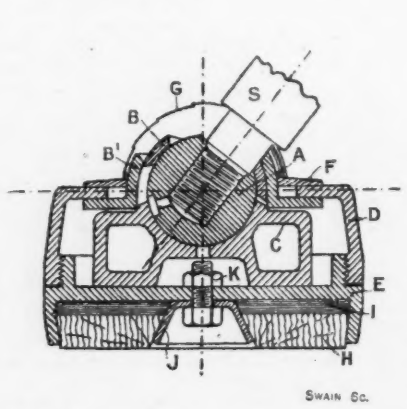


Fig. 31—SECTIONS OF PEDRAIL FEET

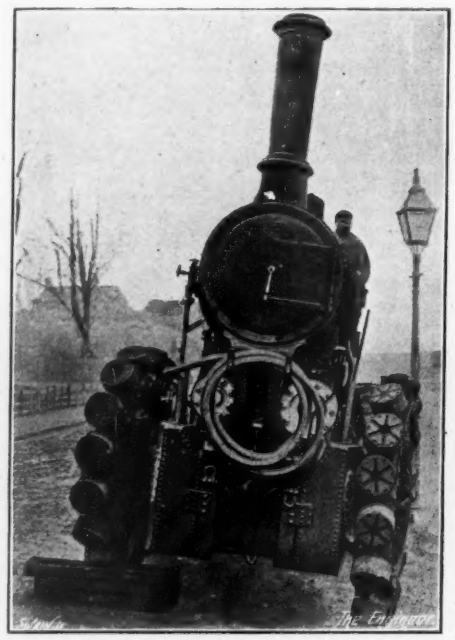


Fig. 32—DIPLOCK'S ORIGINAL PEDRAIL, 1901

by Colonel Crompton in 1899, and which has already been referred to, had fitted to each of its wheels a

* It is to be borne in mind that the book containing these words was published in 1902.—Ed The E.

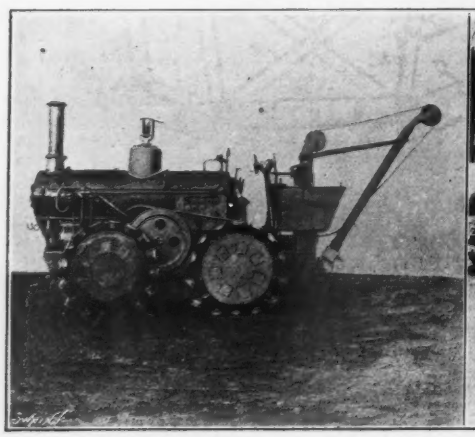


Fig. 33—PEDRAIL No. 2—1903

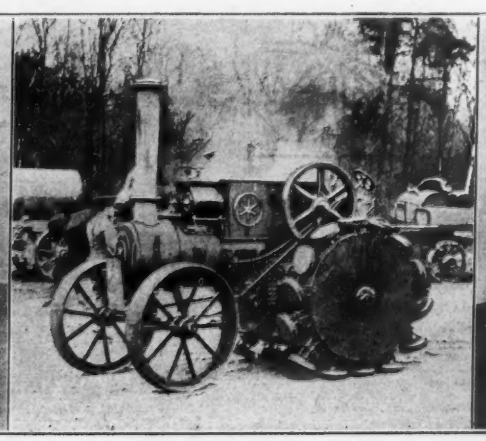


Fig. 34—PEDRAIL No. 3—1905

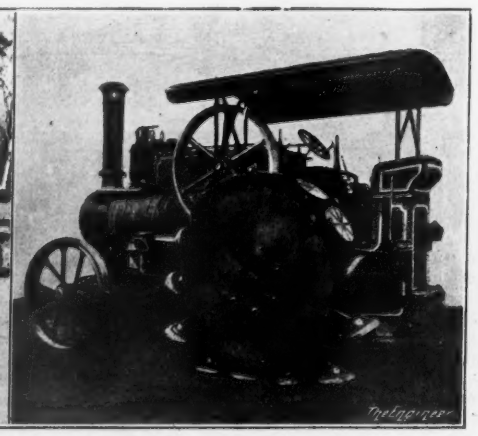


Fig. 35—PEDRAIL No. 4—1908

set of Pedrails, there would never be less than eight and there might be as many as twelve feet on the ground at the same time. Call this an average of ten. The feet of a full-sized Pedrail tractor were about 9in. in diameter, so that as a total there would be a bearing surface of some 63.6 by 10, say, 636 square inches. This area compares with that covered by the portions of the two wheels of an ordinary two-wheeled traction engine when in contact with the ground.

We may incidentally remark here that, with a view to reducing friction as much as possible, Mr. Diplock provided the sliding spokes with ball bearings, which was, he believes, the first application of this form of bearing to a reciprocating motion.

The design of the feet was interesting and ingenious.

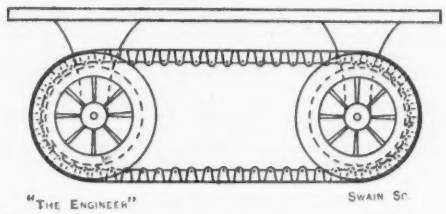


Fig. 30—SKETCH SHOWING BEAMOND'S PROPOSAL, 1900

Sections of one of the feet are given in Fig. 31. At the end of each spoke S is a ball A, which works between two cup-shaped blocks B and C. The upper block is made in two parts, B and B^1, one inside the other, so as to give a better movement, and more lap over the ball than would a single one. The blocks B and C are held together by an outer covering or shoe D, into which is screwed the sole E. The screw admits of any wear of the parts being taken up, and the sole is prevented from unscrewing by a cotter and split pin, which are not shown in the drawing. All the parts are circular in plan, and the parts B^1 and C are smaller in diameter than the shoe, so that they

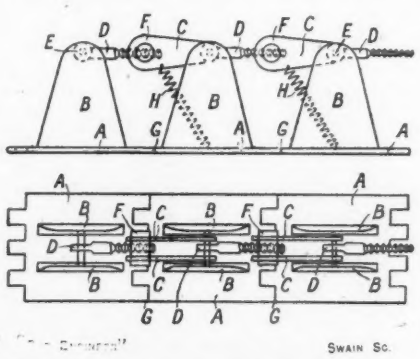


Fig. 31—SECTION OF BEAMOND CHAIN TRACK

can slide about to a certain extent inside the latter. This sliding movement was to enable the varying distance between the feet when on the ground to adjust itself. When turning corners the cupped blocks, and hence also the ball and the spoke, in two of the feet, slide sideways in the shoes, while the ball of the third foot—if on the ground—pivots. A mixture of castor-oil and blacklead is put inside the shoe for lubricating purposes.

Dust is excluded by a flat ring F, surmounted by a series of metal rings G, forming a hemisphere, which telescopes over each other with the movement of the ankle joint, as shown in the right-hand drawing in Fig. 31. The sole of the shoe has a cone-shaped flange

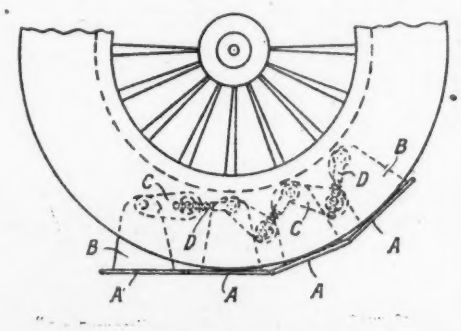


Fig. 32—BEAMOND TRACK APPLIED TO PNEUMATIC TIRE

H, inside which are arranged renewable hard wood segment H, which press against a rubber pad I, pierced with holes to allow of compression. The wooden segments are held in place by a centre cone J, which is fastened by a nut and split pin K.

What Mr. Diplock describes as being a very important feature in the original Pedrail was the oscillating rail. "A horse," he points out, "when stepping on to rising ground, shortens its leg by bending its knee." By reason of the fact that the rail D—Fig. 29—is pivoted at its centre to the plate E, when one of the feet encounters rising ground, the rail and other parts assume the position which is shown, in its extreme possible angle, in Fig. 30. The spoke of the foot meeting the rising ground is thus shortened to suit the altered level, while the spoke at the other end of the rail is lengthened, and thus continues to carry its share of the total weight. "In effect," adds Mr. Diplock, "the oscillating rail forms an inclined plane on rollers, well known as the best mechanical means of running a weight over an obstacle with the minimum of power."

The first pair of Pedrail wheels was completed towards the end of 1901. It was applied to the front driving axle of a traction engine—see Fig. 32. A second pair of Pedrails was afterwards applied to the rear axle of this engine—see Fig. 33. A third pair of Pedrails was applied to the rear axle of another engine—see Fig. 34—and that engine was tried by the War-office at Aldershot in the beginning of February, 1905. That particular engine is still in existence, and has now, we believe, travelled some three thousand miles in all. A further application was made to another engine—see Fig. 35. In each of the last-mentioned engines there were modifications, especially in connection with the arrangement of the feet mechanism. Into these, however, we have not space to go, for they do not actually affect our immediate subject. It is worthy of note that even in these earlier machines, which were the forerunners of the chain-track vehicles—to be alluded to later—subsequently designed by Mr. Diplock, there was no direct connection between the various feet, saving that each was attached to a spoke which slide in bearings mounted on the central disc. Mr. Diplock has all along maintained that it is a mistake and the cause of much loss of power by friction to hinge adjacent feet rigidly together. It is true that, as we shall show in due course, he, in later patents, connected the feet carriers together so as to form endless chains; but, in all cases, he left the feet themselves free to move within limits independently of one another.

The patent of Frank Loescher Bramond, of Sutton Coldfield, No. 1673 of 1900 may now be mentioned. A view showing, diagrammatically, the invention applied to a pneumatic tired vehicle, is given in Fig. 36, while enlarged views of a portion of the endless track may be seen in Fig. 37. The arrangement is intended to be applied either to each single wheel or to the two pairs of wheels of a vehicle, as shown in Fig. 36. It will not be necessary to describe this invention very fully, but it may be explained that the tracks are made in sections, each section consisting of a base plate A near the middle of which are two flat upright standards B, tapered to their apices, and spaced to allowed room for two links C and an adjustable threaded pin D, which connect the standard at the top with the adjoining section, to come in between them. The two links are pivoted at one end to the pivot E, which passes through the upper end of the standard, the other end being attached to the pivot F, which is pierced and threaded to receive the projecting end of the threaded pin D. The other end of this pin is connected to the pivot E of the adjoining section. The base plates A are hinged at G, so as to form a chain or series, while the links C, and the adjustable pins D, by keeping the standards B at set distances apart, "ensure," to use the inventor's own words, "a horizontal base, thus forming an even surface for the wheels to travel on." As the tops of the standards manifestly must come nearer together as the series of base plates embrace a wheel, the links C and the pins D, instead of being in a straight line, as shown in the

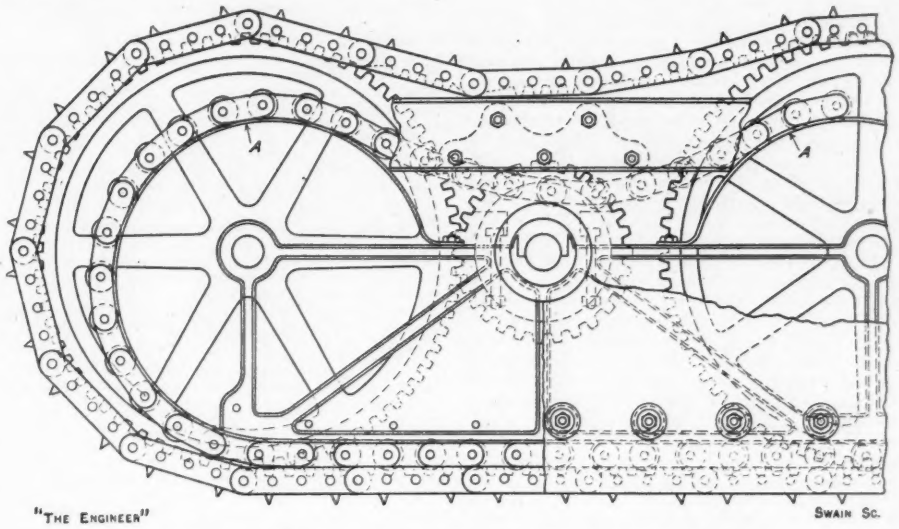


Fig. 39—THE LOMBARD CHAIN TRACK AND ANTI-FRICTION ROLLER CHAIN, 1901

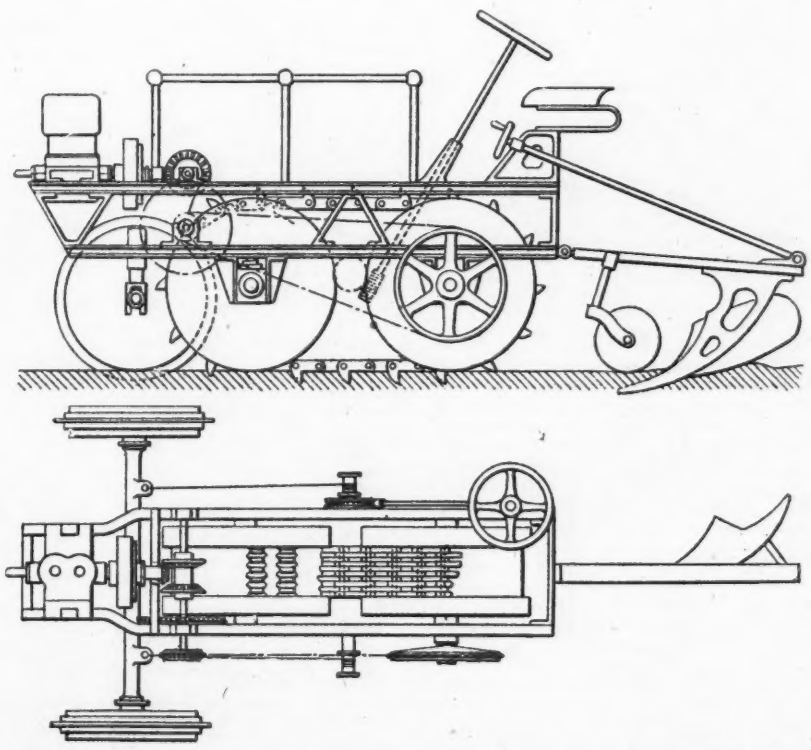


Fig. 40—THE SIMMS PLOUGHING TRACTOR, 1902

upper view of Fig. 37, assume the positions shown in Fig. 38, and springs H are provided to assist them taking up these positions.

In the year 1901 a Mr. Alvin O. Lombard, of the Lombard Steam Log Hauler Company, of Waterville, Maine, entered the field with his United States patent, No. 674,737, which is dated May 21st. One of the drawings from the specification is reproduced in Fig. 39. The inventor's chief object was to construct an engine which might be used on packed snow or soft muddy roads, so that heavy loads of timber might be hauled about in all types of weather and at all seasons of the year. He claims, however, that his invention is applicable to automobiles and for all kinds of farm implements. The engine as described is made up essentially of three parts—a carriage and two "traction members," one on each side of the carriage. The carriage is mounted on a framework which connects the two traction members and ties them together, and it has mounted on it an engine, the crank of which drives the pinion, which is seen meshing with the large toothed wheel on the left-hand side of the drawing.

Each of the traction members consists of a frame, two cogged driving wheels, and a cogged traction belt which meshes with the driving wheels, and two anti-friction roller belts. The frame consists of two vertical parallel trusses, each of which has a top and bottom chord. The top chords support boxes, in which the crank shaft and the shafts of the cogged wheels are journalled, while the bottom chords provide a bearing surface for the roller belts and support the weight of the machine. Each pair of these chords is tied together by a system of vertical members, all formed integral with the chords. Secured to the end of the bottom chords, and curved up and over and secured to the top chords are four guides A A for the roller belts. The cog wheels are provided with cogs, which are slightly rounded to fit cogged tracks in the traction belts. The latter are composed of a series of cogged sections, the racks of which occupy the centre portion of the sections. The sections have side members attached by rivets, and are bored at the ends to accommodate pintles, by which they are secured together. The faces of each of the racks are provided with two or more ribs, which serve to keep the machine from slipping and sliding. These are shown in the drawing to be triangular in cross section, and would, doubtless, have been most effective on snow or bad roads. Their effect on a good road would have been most injurious, so, no doubt, if the Lombard system has been applied to ordinary road locomotives or automobiles, about which we have no information, they will have been omitted. Each of the roller belts is composed of a system of rollers, with horizontal axes journalled in side plates which serve to connect the rollers together in an inextensible chain. We shall have occasion to refer in later articles to other inventions of Mr. Lombard.

A further patent, No. 12,824 of 1900 was taken out by Mr. H. G. Tipping, whose patent, No. 16,699 of 1886, has already been discussed. Mr. Tipping's later invention deals with the construction of wheel plates for endless plate ways, and is particularly concerned with the making of stronger joints.

Patent No. 21,378 of 1900, taken out by William Williams, of Mount Gambia, South Australia, was for an invention which resembled that of the Messrs. Woodbridge—No. 1804 of 1882—referred to earlier in these articles. The drive was, however, direct from the crank shaft to the periphery of the wheel. Adjusting jockey pulleys are also included in several of the arrangements shown in the drawings.

The proposals of Mr. Frederick Richard Simms, of Bermondsey, are so well indicated in the drawings which accompanied his specification—No. 910 of 1902—which we reproduce in Fig. 40, that no detailed explanation is necessary.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE EVOLUTION OF THE CHAIN TRACK TRACTOR.

Sir,—In reading the opening numbers of the series of articles on "The Evolution of the Chain Track Tractor," which is now appearing in your columns, it has struck me that it might, perhaps, be of historical interest to recall two patents which I took out in 1870, namely, Nos. 599 and 2620. I had previously introduced a method by which india-rubber could be attached to metals during vulcanisation, and it was the application of this method to the construction of vehicle wheels which formed the subject of both these patents.

The first invention, No. 599, consisted in forming tires of segmental blocks of india-rubber, chemically united in the process of vulcanisation to segmental metal plates. These segmental plates, with their blocks of india-rubber, were secured to the rim of the wheel so that a tire consisting of a series of rubber blocks was formed. A vehicle with wheels of this type was submitted to the War-office authorities, who said that without shoes outside the rubber the invention would be of no practical use to them.

I accordingly designed and patented, later in the same year, a method of furnishing these shoes, and it is shown on the drawing accompanying the specification which I enclose herewith. It will be observed that the wheel was first of all furnished with a rubber tire attached to the metal rim in the manner already alluded to. Embracing this tire was a series of staples, or—as an alternative—bolts might be used. Both staples and bolts were free to slide or move inwards when the portions of the tire to which they were fitted yielded under the pressure of the weight of the vehicle. When staples were used the two sides of the staples were carried down the two sides of the elastic tire and of the metal rim of the wheel, which was recessed, and was provided with lugs or guides to receive them. They were fastened by transverse bolts or pins.

When making use of bolts instead of staples, as shown in the drawing in the right-hand top corner, the bolts, which were provided with broad heads or plates, were carried radially through the tire and through the rim or felloe of the wheel, their inner ends being secured by nuts. So as to prevent the heads of the bolts slewing round they were made square, the ends of the bolts being left round to receive the nuts. The apertures in the tire and rim of the wheel were, of course, also made square.

I may add that I supplied a number of wheels of this type to the War-office authorities.

L. Sterne.

London, August 27th.

THE LATENT HEAT OF STEAM.

Sir,—After reading Mr. Aspinall's recent articles on "Latent Heat of Steam," I have been waiting patiently for some of our noted engineers to criticise them, and up to the present have been disappointed. I greatly admire your altogether commendable and broad-minded action in deciding to publish Mr. Aspinall's articles against the advice of engineers whom, I understand from your editorial, you approached, and who evidently tried to dissuade you. I have not had an opportunity of going very carefully into Mr. Aspinall's figures; he may or he may not have discovered an error in our present steam tables. At the same time I cannot understand the attitude of mind of an engineer who would attempt to stop the publication of experiments simply, apparently, because the results differ fundamentally from figures that have been accepted up to the present. Evidently the engineers to whom Mr. Aspinall's experiments were submitted could have had no good grounds for advising you against their publication, and I can only assume that, not being satisfied with any objections that they may have raised, you wisely came to the decision that they should be published.

If our present steam tables are wrong, then our best plan is to cut them out root and branch, and start again with correct ones; but if the gentlemen you approached are convinced that Mr. Aspinall is wrong, they must have good grounds for thinking so, and it is the greatest pity that they do not come forward so that we may know what they consider are the errors into which Mr. Aspinall has fallen. Surely the subject is of too much importance to be allowed to drop. It would be most disturbing, no doubt, to find that existing tables and theories are at fault, and perhaps this has something to do with their reticence. Steam.

August 26th.

COAL ECONOMY.

Sir,—I notice that Mr. Casmey sticks to his belief that he has found the perfect CO_2 recorder. I wonder—but it is not good manners to wonder—just how long that faith will endure in terms of practical experience. With all my heart I hope that his happiness may be permanent, but why in the name of national economy does he not persuade the makers to come forward, and let the whole world share the benefit?

In the meantime, I advise that he read thoughtfully Mr. Townsend's letter on the same subject. If when Mr. Townsend's instrument shows high CO_2, his chimney shows black smoke, either the instrument is wrong or the theory that perfect combustion and high CO_2 go together wants overhauling—which, of course, is absurd.

The plain fact is that the ordinary recorder lags something like 45–60 minutes behind the true composition of the flue gases (v. report on CO_2 recorders of the U.S.A. Bureau of Mines). Such a record may be better than nothing, but it needs no labouring to show that as a practical control for the stoker in the management of his fire, its value is not remarkable.

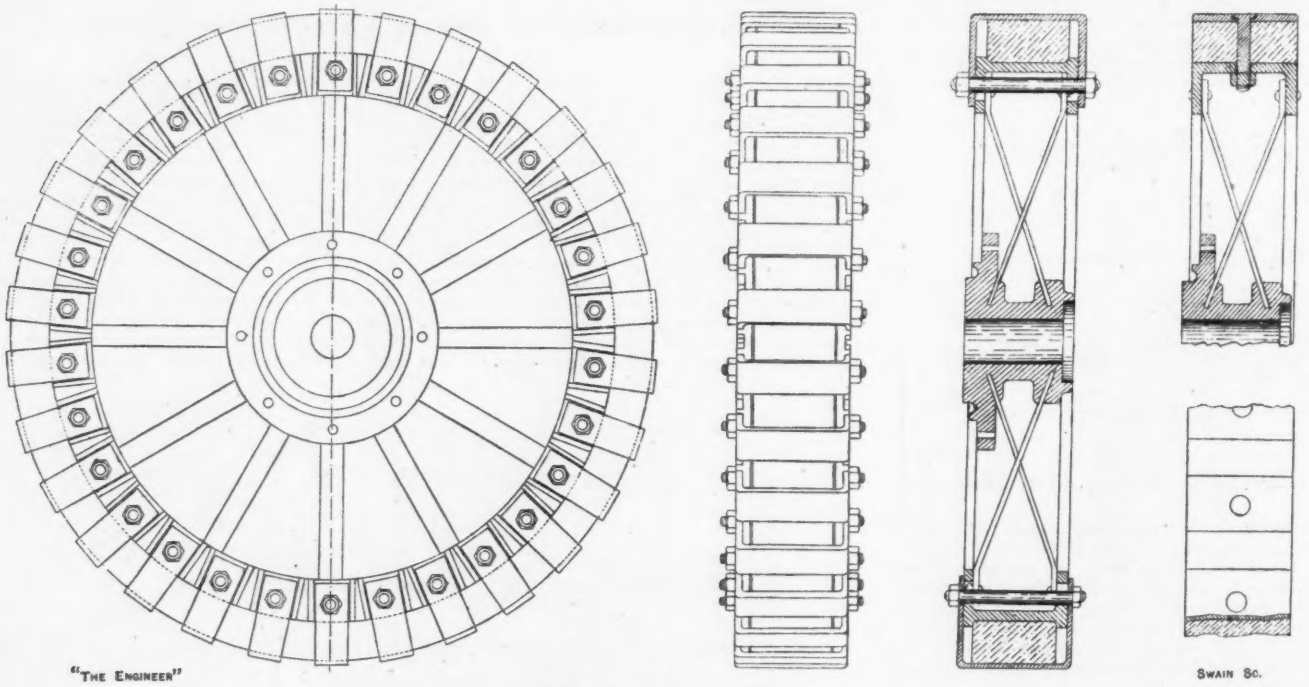
Perhaps Mr. Casmey has got hold of an instrument that really goes one better. Steam-Raiser.

August 22nd.

PYRMONT BRIDGE.

Sir,—I wish to thank Mr. Allan for his explanation of the points I raised. With regard to the method of distributing the loads from the main girders to the distributing girders, I note that the total load from X is supposed to be carried by A, and the total load from Y entirely carried by B. This, however, is rather a bold assumption, as it depends on the relative movement of the cross diaphragm and girder Y—considered independently—at the point where they intersect. If these deflections were calculated, assuming in the first place that they were independent girders, it would be found, in the event of this point on the diaphragm being raised higher than the corresponding point on Y, that there would be an increase in load on girder A and a decrease on B, and *vice versâ*. This is a somewhat difficult and laborious calculation, but a very slight difference in these deflections might make considerable difference in the loads on A and B. It also means that the reactions on the inner girders, which really have six supports, two of which are elastic, are practically indeterminate. It seems to me a simpler and more determinate method of distributing these loads might have been used to advantage. H. R. White.

London, August 28th.



THE STERNE RESILIENT WHEEL

TYPES OF IRISH LOCOMOTIVES.

Sir,—In the list of "Irish Locomotives" published in The Engineer for August 24th, a correction should be made in the total of the goods engines. This should read:—

4 wheels coupled goods engines	8
6 „ „ „ „	338
	346

Instead of 346 engines with six coupled wheels.

I should be glad if you would make this correction.

E. L. Ahrons.

Nottingham, August 25th.

THE EVOLUTION OF THE MONITOR.

Sir,—In connection with the recent article on this subject, which appeared in your issue of August 17th, and the letter signed by "The Writer of the Article," which appeared in the issue of August 24th, I should like to call your attention to an illustrated article which appeared in your issue of October 30th, 1874. It contains an account of an early form of turret ship, taken from Louis Pierre Baltard's "Essai sur la Fortification et sur les Tours à batterie tournante" (Paris, 1831), a copy of which is in the Patent-office library. R. B. P.

August 28th.

RAILWAY MATTERS.

Up to a recent date there had been 2998 members of the National Union of Railwaymen killed in action or had died from wounds.

The Board of Trade has held an inquiry into a fatal derailment on the 19th inst. of a tramcar at Dover. Ten people were killed, and one has since died.

The Divisional Food Commissioner for the North Scotland district is Mr. William Roberts, who, until recently, was the chief engineer of the Highland Railway.

The new Parliamentary Secretary to the Board of Trade, Mr. G. J. Wardle, is the son of a Midland Railway carman, and he, himself, was a clerk on the Midland Railway from 1880 to 1898, when he was appointed the editor of the *Railway Review*.

According to a bulletin issued by the American Iron and Steel Institute, based on statistics furnished by the various manufacturers, the total production of rails in the United States during 1916 was 2,854,518 tons. This is 650,315 tons more than the production of 1915, and nearly double that of 1914.

In giving evidence before Mr. T. R. Johnson, who is inquiring into the working of the Victorian Government Railways, Mr. W. M. Shannon, the chief mechanical engineer, said that the adoption of superheaters should save 12½ per cent. of the fuel consumption, and had 200 of the engines on the Victorian railways been equipped with superheaters there would have been a saving last year, when coal was 15s. 10d. per ton, of £11,378. At present coal was 21s. 1d. per ton, and, therefore, there would have been a saving of £17,000.

The official returns of forty-one of the principal tramway undertakings in the United Kingdom, as published by *The Tramway and Railway World* for the week ended August 11th, which included the August Bank Holiday, give total receipts of £226,177, or £27,661 more than in the corresponding week of last year. The total length of track included in the returns was 2143 miles. The receipts this year were at the rate of £105 10s. 10d. per mile of single track, and last year at the rate of £92 12s. 8d., thus showing an increase for the week of £12 8s. 2d. per mile open.

The general increase in the rates of wages, piecework prices or bonus granted to men, youths, and women employed in railway shops as the result of any awards given by the Committee on Production, or as a consequence of agreements with the railway companies, has been replaced by an advance of 15s. per week to all men on time work; an advance of 8s. per week in wages, and of 7s. per week if on time rates, or of 17½ per cent. increase in piecework prices; boys and women have an increase of 2s. per week in their bonus, and girls of 1s. This is not to apply to those who are paid in accordance with the recognised district rate of wages.

The exports of railway material for the seven months of the present year were as follows, the corresponding figures for 1916 being shown in brackets. Locomotives, £958,573 (£727,500); steel rails, £409,262 (£311,430); carriages, £109,557 (£261,093); wagons, £276,552 (£404,219); wheels and axles, £87,645 (£192,733); tires and axles, £336,859 (£312,888); chairs and metal sleepers, £56,429 (£79,526); miscellaneous permanent way material, £281,868 (£279,868); total permanent way material, £750,246 (£716,491). The weight of rails exported in the seven months was 24,403 tons (31,763 tons), and of chairs and metal sleepers, 4250 tons (8569 tons).

A concession has, it is said, been granted to Don Miguel Otamendi for the construction and working, for a period of ninety years, of an underground electric railway system in the Spanish capital, to be known as the Metropolitan de Madrid Alfonso XIII. There will be four sets of metals. The capital necessary for the construction of the complete system, embracing a total distance of 14 kiloms. (8¾ miles) is rather over £1,000,000. A period of eight years will be allowed for the completion of the undertaking. The first line to be constructed will cross the city from north to south; it will be 4 kiloms. (2½ miles) long, and is estimated to cost upwards of £300,000. Work is to be commenced shortly, and this section must be completed within three years.

The chairman of the storage facilities sub-committee of the General Munitions Board of the United States believes that unless that country learns to load, route, and handle its freight cars more efficiently, America soon will be in as bad a situation as some of the European countries. "In England," he says, "many classes of non-military shipments can get the use of the railways only one day in seven. We are going to appeal to manufacturers to help, by assembling and shipping stores so as to require the minimum of handling and haulage." In the handling and storage of supplies for the army he proposes to establish points of local assemblage, at which goods in less than car-loads can be temporarily stored, and full car-loads made up for shipment. In the accumulation of such stores, motor trucks will be extensively used. In England, it is observed, any haul under forty miles is considered a motor-truck haul; and it is hinted that a similar rule will be made in the United States.

The railroads of the United States, as part of their effort to make available a maximum of transportation energy for the movement of freight, have already reported the elimination of passenger trains aggregating 16,267,028 miles of train service per year. The elimination of passenger service now reported will make available for other purposes over 1,120,000 tons of coal. The Pennsylvania system eliminated 3,300,000 miles of train service, thus saving 186,876 tons of coal. The New York Central plans to save 126,000 tons of coal. The Erie has cut outk 1,600,000 passenger train miles; the Baltimore and Ohio, 1,168,596; the Chesapeake and Ohio, 850,000. Roads in New England have arranged to eliminate 4,847,332 passenger train miles with a saving of 256,724 tons of coal. The Boston and Maine cuts out 2,118,948 miles of service; the New Haven 1,707,004, and Maine Central 442,676. The Pere Marquette and the Wabash, the only roads reporting as yet from the Central, have eliminated together 846,600 miles of service and plan to save 49,555 tons of coal. The Southern Railway has cut out 1,900,000 passenger train miles and will save 97,282 tons of coal.

NOTES AND MEMORANDA.

According to Mr. William M. Barr, in *Industrial Engineering*, the melting points of various samples of firebrick, as determined in an electric vacuum furnace, the temperature being measured with an optical pyrometer, were as follows:—Kaolin, 1740 deg. Cent.; pure alumina, 2010 deg. Cent.; pure silica, 1600 deg. Cent.; bauxite, 1820 deg. Cent.; bauxite clay, 1795 deg. Cent.; chromite, 2180 deg. Cent.; magnesite brick, 2165 deg. Cent.

Japan's copper ore output in 1916 was 111,562 tons, as compared with 83,017 tons in 1915, and 78,700 tons in 1914. Exports amounted to 57,402 tons in 1916, as compared with 56,528 tons in 1915, and 43,305 tons in 1914. Russia now buys 60 per cent. of Japan's copper exports; the United Kingdom takes 20 per cent., while France, the United States, and India share the remainder. The consumption of copper ore in Japan has increased considerably during the last three years, amounting in 1916 to 59,690 tons, as compared with 27,723 tons in 1915, and 32,045 tons in 1914.

During 1916 the value of the New South Wales mineral output was £10,975,742, a total which is the third highest in the history of the State. It exceeds that of 1915 by £911,173. The high prices ruling for the industrial metals, notably copper, are mainly responsible for this result. The increase is general, the only branches of the industry which show decreases to any extent being gold, coal, and zinc. It is estimated that 31,304 persons were employed in and about the mines during the year, or a decrease of 107 when compared with the preceding year. The aggregate value of all minerals won in New South Wales to the end of 1916 was £273,154,084.

The Harbour Master at Hong-Kong, in his report for the year 1916, states that the total of shipping entered and cleared at ports in the Colony during that period was 642,794 vessels of 36,381,487 tons, which, when compared with the figures of 1915, show an increase of 111,192 vessels and 2,496,538 tons. Of the above, 48,350 vessels of 22,308,311 tons were engaged in foreign trade, as against 50,148 vessels of 22,515,023 tons in the previous year. The actual number of individual ocean-going vessels of European construction which visited the port during 1916 was 717, measuring 1,605,248 tons. Of these 281 were British, 272 Japanese, and the remainder of various other nationalities.

During the week ending April 21st, 1917, there was not, says the *Engineering News Record*, a case of an employee of the Canal or Panama Railroad on the Isthmus being admitted to sick report for malaria. This was the first time in the history of the Canal that a week has passed without the occurrence of malaria among the employees. It has occurred several times that either the Zone or the terminal cities had no cases, but this was the first time that no new cases had occurred in a week in both the Zone and the terminal cities. The number of admissions from malaria in March was 23; in February, 18; and in January, 31. The average per day to the 1st of April was 0.8, which is equivalent to 5.6 per week. In the calendar year 1916 the number of employees treated for malaria was 547, an average of 10.5 per week.

The production of sugar in the Island of Java in 1916 amounted to 26,408,100 piculs—a picul being about 133 lb.—as compared with 21,178,700 piculs in 1915, and 22,655,274 piculs in 1914. It is estimated that the area under cultivation this year will be slightly larger than in 1916. Prospects for 1917 are favourable; the coming crop looks well, and, given good weather conditions, should be fully equal to that of last year. Exports of sugar from Java from April 1st to December 31st, 1916, amounted to 1,234,200 tons, as compared with 1,152,300 tons and 1,018,200 tons during the corresponding periods in 1914 and 1915 respectively. The principal shipments during 1916 were made to the United Kingdom (537,800 tons), British India (314,100 tons), Hong-Kong (104,600 tons), and France (64,700 tons). It is estimated that at the end of 1916 about 2,000,000 piculs of sugar stored in Java remained still for disposal.

The Russian cotton seed oil industry is established for the most part in the Ferghana, Murgal, and Merw districts. The cotton seed from the first-named district contains a high percentage of oil specially suitable for refining. It is stated, says the *Chemical Trade Journal*, that in the Ferghana mills there are more than thirty 16in. hydraulic presses, seven 12in. presses, and several small ones. The total quantity of cotton seed formerly treated was about 144,000 tons per annum, the working year being 250 days. The yield of oil was approximately 21,600 tons, in addition to 48,000 tons oil cake. Just lately two new mills have been established, and the old mills have been enlarged. The output, therefore, is considerably increased, and the total quantity of cotton seed dealt with is now about 192,000 tons. The export of cotton seed from Turkestan in 1913 was about 20,320 tons. It is said that one pood (36 lb.) of cotton seed of first quality will yield 6.56 lb. of unrefined cotton seed oil, 14.4 lb. oilcake, and 18 lb. husks, the remainder consisting of linters and other waste.

Some particulars regarding the health of natives working in the South African mines are given in the *Mining World and Engineering Record*. It appears that, among natives employed in the mines during the last seven years, there were over 50,000 cases of pneumonia, resulting in 12,721 deaths, and the loss of over 1,000,000 working shifts. Dr. Lister, of the South African Medical Research Institute, has shown that there are several varieties of pneumococci bacillus, which causes pneumonia, and that a vaccine can be prepared which will immunise against attack of the particular type of pneumococcus contained in the vaccine. As a result the Institute is now making vaccine which appears to render natives immune from infection by three strains of pneumococci, which are responsible for most of the cases of pneumonia among mine natives. Systematic tests are being carried out at the Premier diamond mine, at De Beers mine, Kimberley, and on the Crown Mines property with distinctly promising results. The members of the Native Contingent sent to France were all inoculated with the South African Medical Research Institute vaccine, and it is said that they were singularly free from pneumonia, in spite of the severity of the past winter.

MISCELLANEA.

The steamship War Wasp, the first steel ocean-going steamer built in Nova Scotia, was successfully launched recently by the Nova Scotia Steel Company. Work on the vessel was commenced in October last.

The Astillero Vea-Murguia, an abandoned shipbuilding yard outside Cadiz, is to be re-equipped. The *Iron and Coal Trades Review* understands that the intention is to use the works at first for the construction of railway wagons and other rolling stock, but the plant is to be gradually enlarged and ultimately to resort to its original purpose of shipbuilding and repairs.

The chilling of cast iron, as a result of sudden cooling when poured against an iron inset in the mould, is said, according to the *Ironmonger*, to have been an accidental discovery. In an English foundry, in the eighteenth century, the slopping-over of a ladle of cast iron caused part of its contents to come in contact with the cold iron lying on the floor. In breaking up this scrap it was discovered that the iron was white and much harder than that secured from the ordinary foundry process of pouring the metal against a sand face.

About 40,000 square miles, or 26 per cent. of the total area of California, have not been mapped by the United States Geological Survey. Almost half this unmapped area lies in fertile and productive territory, and 20 or 30 years would be required to complete the maps at the present rate of progress. At present the annual appropriation by the state legislature is some £2800. Since state appropriations are supplemented by an equal amount of Federal funds, organised effort on the part of engineers is being directed toward increasing California's appropriation to £5000.

The Supplement to the *Board of Trade Journal* of 30th August contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from Denmark, France (including Algeria), Italy, Japan, and the Netherlands. The Supplement also contains the list of articles (complete to date) which are prohibited to be exported from the United Kingdom. Copies may be obtained at a cost of 3d. (3½d. post free), either from any bookseller, or from His Majesty's Stationery Office, Imperial House, Kingsway, London, W.C. 2.

In an article on concrete ships, the *Canadian Engineer* remarks that such vessels may not be quite as economical of operation as steel ships on account of their extra weight, but when capital and repair accounts are taken into consideration it is not so certain that they will be at any great disadvantage. They require no painting, no renewal of rivets, and repairs to the hull, when required, can be made at a fraction of the cost of the repairs to a steel hull. The first cost of a concrete hull will, continues our contemporary, be considerably less than half the cost of a corresponding steel hull.

To meet any possible coal shortage in the western parts of the United States next winter, more extensive use of fuel wood from the National forests is urged by the Government's foresters. The supervisors of the 153 National forests have been instructed to afford all possible facilities to local residents wishing to obtain cord wood, which settlers may obtain free for their own use, and which is sold at low rates to persons cutting and hauling in order to sell to others. During the last fiscal year more than 30,000 permits for the free use of National forest timber, mainly in the form of fuel wood, were taken out by local residents. The amount of timber involved approximated 250,000 cords.

What is claimed as the tallest chimney in the world was, says the *Iron and Coal Trades Review*, recently completed for a copper smelter at Sagonoseki, Japan. It is constructed of concrete, 570ft. high, 26½ft. inside diameter at the top, and 42ft. in diameter at the base. The great height was decided on to carry the fumes from the smelter to an altitude that would avoid killing the surrounding vegetation. The foundation, which is 95ft. in diameter, contains 2700 cubic yards of concrete. For 150ft. the chimney is reinforced by a concrete lining separated from the outer shell by a 5ft. air space. The opening at the base is 31ft. high and 20ft. wide. The flue connecting the furnaces and chimney is 30ft. in diameter, and 2500ft. long, and is provided with openings for cleaning. In the construction of the chimney 400 tons of steel were used.

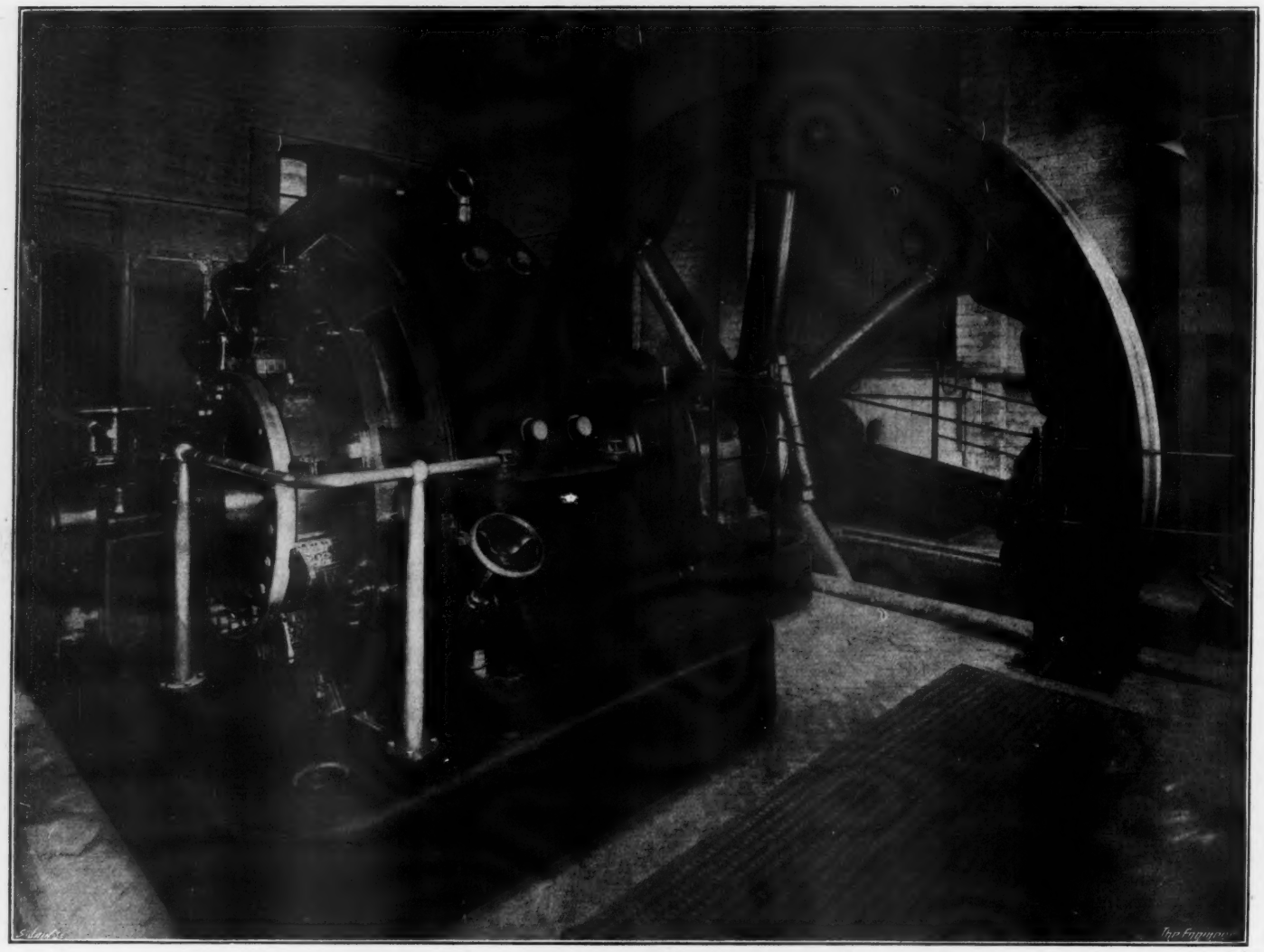
Discussing the melting of scrap aluminium, the *Ironmonger* remarks that there are more ways than one of melting this metal, and points out the curious fact that with this metal the oxide is so nearly of the same specific gravity as the metal that it does not allow the molten metal to clear itself when in small globules or grains. For this reason mechanical aid has to be given. In practice the scrap is so far heated in the crucible that it becomes a pasty mass, in which state it is squeezed and kneaded for some time, preferably with an oak or other hard wood rod of fair cross area, and then the heat is raised, and with some manipulation of the rod the metal is cleared of the dross and dirt. If melted rapidly, a dirty mass of metal and oxide is produced with a heavy loss of actual metal held in the skimmings from which it cannot dissociate itself, owing to its slight weight.

In view of the importance of internal waterways and of the many questions which revolve round the development of the hydraulic resources of its country, the National Association of Navigation Congresses in Italy has, says *Nature*, inaugurated the publication of a small periodical of eight pages, known as *Navigazione Interna*, to deal with matters of interest in that connection as they arise. The first issue, for May, 1917, contains an account of the work of the Hydrotechnical Institute at Stra, associated with the University of Padua and the Hydrographic Department at Venice, describing in particular the experimental tank 200 m. (656ft.) long, with a bottom width of 3.70 m. (12ft.), a top width of 10.75 m. (35¼ft.), and a mean depth of 3.50 m. (11½ft.). The tank is constructed in concrete, with light metal reinforcement, and is fitted with a moving platform and the appropriate mechanical equipment. The institute undertakes experimental work in connection with all hydraulic problems, including those regarding the resistance offered to the movement of solid bodies in water.

ELECTRICALLY-DRIVEN 20-INCH BAR MILL

(For description see page 190

GENERAL VIEW OF THE MILL



THE MOTOR AND FLY-WHEEL

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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INQUIRIES.

TOY MARBLES.

SIR,—I should be very much obliged if you or any of your readers could inform me whether there are any makers in this country of machinery for making toy marbles.

W. M. S.

THE ENGINEER.

AUGUST 31, 1917.

Labour and the State.

THE promise that the inquiry of the Commissioners appointed to investigate the causes of industrial unrest would be followed by immediate action on the lines indicated in the reports, is being kept both in the spirit and the letter. It would be difficult, and perhaps impossible, to find in the history of Government Commissions any other instance where the reforming hand has moved so swiftly. In the past the appointment of a Royal or other Commission to take evidence and report was the conventional way of shelving inconvenient questions. The dust has gathered thick upon the mass of Blue-books containing evidence and recommendations on a bewildering variety of subjects which politicians have side-tracked by this method in the hope that they would be forgotten. We live to-day in a different environment; the atmosphere is charged with elements which have led to a quickening of the whole national organisation. The object in appointing eight Commissions to search out the causes of industrial unrest in different areas of the country was that legitimate grievances could be ascertained, and remedies provided with a minimum of delay. Some of the critics who have suggested that hurried inquiry is being followed by precipitate action, and who point out that the impossibility of dealing with the deep-seated permanent causes of industrial unrest by hasty legislation have failed to grasp the real questions at issue. If the reports of the Commissioners are read with the care which some of them, at least, merit, it will be found that their recommendations are almost entirely confined to the removal of grievances arising out of working conditions in connection with war work, which in the national interest demand attention without delay. There is no attempt in any of the reports to do more than hint at the need of dealing with questions, the answers to which are only to be found in the reconstruction on a permanent basis of the industrial system. That is the task of the future. What is required at the present moment is the removal of certain irritating, and some cases unnecessary, restrictions and anomalies which threaten the efficiency of the industrial war machine.

The action taken by the Minister of Munitions, and the reforms foreshadowed by Mr. Barnes, indicate the lines of Government policy, and, assuming, as one is entitled to assume, that the reports on unrest have elicited the real facts, what is to be done should put an end to the discontent which was the main cause of the recent engineers' strike, and held the grave threat of a recurrence of that unfortunate episode. Mr. Churchill, from one point of view, is favoured in taking up office at a moment when the work of previous Ministers has ensured the necessary output of munitions, so that he is able to direct his main energies to the solution of the human problem, the importance of which, during the *régime* of his predecessors had been to some extent masked by the pressure for delivery of war materials. It was this neglect to pay attention to the human link in the chain of manufacture which led to a condition of affairs in which it was found necessary to confine dilution of labour to factories working on Government contracts, and to withdraw the leaving certificate system which, in spite of much criticism, had in the past served a useful purpose. These were part of the price which had to be paid for the neglect to redress legitimate grievances at an earlier date, and it is useless at this stage to lament the fact. The statement made by Mr. Barnes, which deals with the other questions raised in the reports of the Commissioners, refers to complaints on the part of workers for which there is a good foundation. Power has already been granted under the provisions of the Munitions of War Amendment Bill for the adjustment of time rates to get rid of the disproportion between the wages of skilled workmen and the high earnings of unskilled men working at piece rates. This has been a source of intense irritation, and the appointment of a Special Committee to include representatives both of Trade Unions and employers to settle this vexed question is an excellent move. The same observation applies to the proposed committee of Trade Unionists to advise the Minister of Munitions on industrial questions. If the composition of this, and the Shop Committees which are to be set up, is such as to command the confidence of the workers, an important step will have been taken in preventing grievances rankling to such an extent as to engender a spirit of revolt. The Food Controller has already made plans to get rid of the disproportion between the rise in cost of living and increases of workers' earnings, and his scheme for the reduction of prices, the stoppage of profiteering and the regulation of the distribution of essential foods, is to be put in operation immediately. Another vital question, that of housing, is being undertaken by the Local Government Board, working through local authorities, and in cases where the housing problem is acute it is hoped that early action will be taken. The modification of the liquor restrictions has already received attention, and additional supplies of beer are likely to be available at an early date in those districts where the original regulations have tended to inflict hardship. The conditions affecting military service are also being modified. There is strong evidence in all these matters of a desire to review legislation arising out of the war in the light of experience, and to make the necessary amendments.

When the reforms thus indicated are put into effect it is hoped that the evil influences which tended to drift the labour movement in the direction of syndicalism will be successfully counteracted, and that that close touch will have been established between the Ministry of Munitions and the workers in controlled establishments which will prevent any further serious manifestations of unrest. It is recognised that the reforms, the need for which is now admitted, are only designed to deal with temporary and exceptional causes of dissatisfaction. The all-important question of establishing those better relations between employers and employed, which must accompany the desired expansion of our manufacturing activities, cannot be satisfactorily dealt with at the present moment. Several organisations are, however, taking the preliminary steps which it is hoped may lead to a closer co-operation, approaching partnership relations, between the hitherto opposing forces of capital and labour, and there is perhaps more room for hope than at any previous period within recent years that a permanent settlement of an old feud may, with a reasonable spirit of compromise on both sides, be secured. It, at least, will be admitted that the steps now taken by the Government should induce a frame of mind in which proposals for new permanent working conditions may be examined without rancour, and with a real desire to effect a settlement.

The Business of War.

THE longer the war lasts the more clear is the revelation that it is a business, as well as a highly specialised art and science. Questions of strategy and tactics have to be studied in the workshop as well as on the actual field of operations if the desired results are to be secured. We were somewhat slow perhaps in learning the lesson, for the reason that practically all the wars in which Great Britain has been engaged have been pure contests between naval and military forces, and have caused but little disruption of the ordinary business and domestic life of the nation. At the outset of the war, therefore, we were content to leave the conduct of actual operations, and even the organisation of supply and transport, in the hands of men who had received their training by service in one of the two arms into which the belligerent forces are divided. It did not, however, require many months' experience to demonstrate that this war could not be won without the co-operation of the engineer with the sailor and the soldier. It is, indeed, a common-place to say now that it is an engineers' war, for all branches of the industry have been mobilised with the sole object of supplying the fighting units afloat and ashore with material. Yet even the industrial revolution which has thus been accomplished, with its profound changes in the character of the work and the conditions under which it has been and is carried out, has not proved sufficient to meet the needs of the greatest war in history. With the

realisation of the fact that the struggle is one between nations as a whole rather than between selected bodies of armed forces has been felt the necessity, not merely to organise the technical training of the engineer for the purposes of supply, but to link to it the business organisation of the country, and so to bridge the gap between the manufacture of materials of war and those whose part it is to use them. Men of business, as distinct from professional politicians, are to be found occupying important positions in departments of State from which they have hitherto been excluded, or which they have had no desire to occupy, and in some instances they have been appointed as heads of great administrations. First, it was railway transport in the military area, then the Board of Trade, next the Ministry of Munitions, the department of National Service, and, finally, the Admiralty, which passed under the sway of business men. These are the outstanding examples which furnish the proof that to the revolution of industry has been added a revolution of the political system.

It will be of interest to consider what is the meaning of the change wrought by the needs of war by which the dreams of the advocates of business Government have been partly, at least, realised. Will the change persist? Let it be at once admitted that in spite of the stones thrown at the old system of Government, not all politicians are inefficient, nor are all business men, even when highly trained, and of proved success in the narrow sphere of special trades, fitted for the task of government. They have been brought into National Service at this juncture because the conduct of the war is a vast business undertaking, in which the want of efficient organisation would be the prelude to partial failure and a patched-up peace. Not only have questions of supply and transport, including the management of our shipping resources, the arrangement of the new shipbuilding programme, the control of food and drink, of coal and other raw materials, been placed in charge of men drawn from the ranks of industry and commerce, but even recruiting for the army, which it might have been assumed was essentially a military task, has been handed over to civilian administration, manned by business men. Yet this last change, significant as it is of the new spirit in public affairs, has caused less comment than the experiment of appointing as First Lord of the Admiralty a man lacking political or naval experience, but possessing, instead, what are supreme gifts at this moment, a proved capacity for organisation, and an ability for getting things done. Almost at a bound the business community, so long excluded from participation in high politics, has come into its own, and is occupying the seats of the mighty. For our own part, we believe that the dramatic change which has taken place is likely to remain a permanent feature of our system of government, and that the needs of war have only hastened and not altered the march of events. The men who are needed to win the war, who have been called in to direct the activities of the inventor, the shipbuilder, and the manufacturing engineer into the right channels, and to see that the chariot of industry is correctly harnessed to the war machine, will be required to act as guides into the paths of peace trading. In the future the task of government will be rather a business than a political monopoly. It has long been evident to those who have the vision to see beneath the surface of things that the best brains of the nation and the highest capacity for administration are to be found among those engaged in industry to a greater extent than in other classes, and now that a worthy task has been set these men they have not hesitated to apply these gifts in National Service. It is one of the ironies of the war that the very qualities of business organisation, which our critics have so often accused us of lacking, should, outside the valour and self-sacrifice of those who stand in the line of battle, be the main reliance for the victory of our arms. The lesson is one which is calculated to make a deep impression, not merely on our own, but on other nations. The United States, keenly observant of old-world developments, who have watched Great Britain and her Empire slowly creating the military, and the manufacturing systems, and the organisations which alone could enable war to be waged under modern conditions, have already taken the lesson to heart, and we know that Germany, whose organisation has at times been pushed to an extreme point, has prepared for war with the completeness which marked her peace methods. She and her allies will be beaten, partly, it is hoped, because of the purer spirit which animates Great Britain and those ranged on the same side, but only, if we and those with us, match our moral force with an organisation to equal it.

Our great ally, the United States, benefiting by our experience, and beginning at the stage we have now reached, is giving first attention to securing the highest efficiency from the industrial and commercial assets which she possesses. The Council of National Defence has already called upon the American engineer to give national service. An Engineering Council has been appointed with the object, not merely of enabling American engineers to co-operate in the national interest, but to do so with the greatest efficiency. This business-like attitude is to be commended, and it is to be regretted that this action, taken partly at all events, on the initiative of American technical institutions, was not a course which commended itself to the Councils of our own Engineering Societies. The first result of what has been done in America was the formation of the Society of Industrial Engineers. This body, which is designed to provide a vehicle whereby the best minds can be enlisted to aid the Government in the present hour of need, and generally to promote industrial efficiency, is a remarkable illustration of the part which will have to be taken, not only by the technical engineer, in providing the materials of war, but by his commercial colleague in seeing that the programme of work undertaken is drawn up with full regard to the precise needs of the conflict, and carried out under conditions which realise the highest efficiency. There is also a clear understanding that the opportunity before the "industrial engineer" to use the term employed in the United States, is not confined to the manufacturing field, but should be extended to the conduct of Government affairs. There is, therefore, hope that not only in England, but in the United States, the reluctance to utilise for national work the gifts which have hitherto been given only to industrial activities is to be finally overcome. In peace, no less than in war, the fate of nations will be found to rest finally on industrial efficiency. The engineer and the business man have been shown to be the corner stones of the national edifice, and they should be fully represented in the house of government itself.

Britain as an Agricultural Country.

Among the many upheavals and reversals of policy brought about by the war none is at first sight fraught with more promise for the future than the revival of British agriculture now being attempted. For many years we were well content to be a manufacturing country, and to draw the bulk of our supplies of food stuffs from overseas. In the earlier days of the war our stream of exports of machinery and manufactured goods largely ceased, and a heavy tide of the same nature set in in the opposite direction. To-day we are strenuously endeavouring to reach a position in which we shall be self-sufficing as regards our essential food supplies, and independent of the overseas countries on whom we have for so long relied. This reversal has been dictated by military considerations, and as a war measure of a country which was unprepared for war, cannot at this late date profitably be criticised. Without doubt, too, the revival of British agriculture as at present being worked out will serve to make things a good deal more comfortable for us during the years of threatened leanness which will intervene between the end of the war and the return of the nations of the world to their ordinary avocations. Thereafter the position is less clear, and as we see it at present, is not altogether free from cause for anxiety. The revival of British agriculture as a war policy is, no doubt under the circumstances, very desirable, but the maintenance of British agriculture on its revived footing, as a settled and permanent national policy, is quite a different matter, and requires quite separate consideration. At present our agricultural policy is primarily a military affair, for the plough is being used in this country to-day first and foremost as a means of defeating our enemy's intentions. In the immediate future, when the war is over, and its principal transitory after-effects have disappeared, our agricultural policy will again become primarily an affair of industrial economics.

Britain is and must remain above all things else an industrial manufacturing country. To attempt to make it simultaneously permanently self-supporting in the matter of essential food-stuffs would involve the revival of agriculture on a scale that would introduce very serious and very undesirable competition between agriculture and manufacturing industry in the land and the labour markets. To illustrate our contention, let us look at the wheat position. In round figures, we require some 150 million cwts. of this grain per year. Before the war we were growing about 40 million cwts., and importing the remaining 110 millions. To make the country self-sufficing, therefore, in the matter of wheat, we require to increase the area under this crop to nearly four times its pre-war figure. Roughly, a ton of wheat is obtained from an acre of land, so that we should need to put 7½ million acres under wheat alone, as compared with something over 2 million acres, as in 1915. We are not going to assume that the area under other crops would have to be increased in the same ratio. We are aware, for instance, that we already produce a large percentage of the total quantity of barley we require, a still larger percentage of the oats, and almost all the potatoes. The point to which we desire to direct attention is that in 1915-16 some 61 per cent. of the total area of Great Britain and Ireland was already devoted to agricultural purposes, the detailed figures being:—for England, 75 per cent.; for Ireland, 73 per cent.; for Wales, 58 per cent.; and for Scotland, 25 per cent. The remaining 39 per cent. of the total area includes not only the land given over to industrial pursuits but all the mountain and heath land. Of the total non-agricultural area 48 per cent. is in Scotland, 27 per cent. in England, 18½ per cent. in Ireland, and 6½ per cent. in Wales. It is therefore numerically impossible to increase the area in this country given over to food raising to more than 1⅔ times its pre-war value, and of this increase nearly half would have to be supplied by Scotland. Whether, with a less extension than this, coupled with an improved use of the land already cultivated, the country could be made self-sufficing as regards food-stuffs, we are not in a position to say. But it is quite evident from the figures we have given that any material increase of our agricultural areas can only be made at the expense of our industrial areas. As regards labour, we have to observe that agriculture in pre-war times engaged over 12½ per cent. of the population, a larger share than fell to the lot of any other single industry. Any material increase in this figure would be a serious matter indeed for the other industries of the country. We have said that Britain is, and always must remain, primarily an industrial manufacturing country. The figures quoted above supply the reason. Agriculture occupies 61 per cent. of the total land in the country, and supports 12½ per cent. of the population. If the entire country were given over to agriculture four-fifths of the present population would be unemployed. At present 39 per cent. of the country's area is devoted to non-agricultural pursuits and supports 87½ per cent. of the total population. On the same scale the entire area of the country, if the present agricultural lands were taken over by industrial manufacturing pursuits, would support a population over twice as numerous as the present. The figures we are here dealing with are arithmetically accurate, but we must not be blind to the fact that they are open for various reasons to certain practical modifications. They should not, we think, be used otherwise than to prove what we desire to prove, namely, that in general terms the area of this country can only be made to support the present population on the assumption that the nation remains predominantly an industrial manufacturing one, and that any attempt to make it agriculturally self-supporting seems bound to react very unfavourably on its other industries.

Division of labour among the individuals of a workshop or factory is the keynote of modern industrial efficiency. Division of labour among the nations, particularly among the nations of the British Empire, must equally promote efficiency. Our Empire is, undoubtedly, intended by Nature to be self-supporting. Its units each have one or more outstanding duties towards the others. The Dominions and Colonies are pre-eminently adapted to grow the food-stuffs and produce the industrial raw materials which we require. To Great Britain falls the duty of supplying the machinery and plant required by our brethren overseas to produce the substances and materials which they send us, and that required by ourselves to treat and manufacture the products received from overseas. This policy of division of duties among the nations must promote efficiency. In addition, it is bound to strengthen the ties between the units of the Empire. The real bonds of Empire in this commercial age lie in bank balances. Let any one unit become entirely self-sufficing—and in particular, let the Mother Country so become—and the first seeds of disruption will be sown. It may be objected that the policy of interdependence, particularly as regards food, has been shown, up to the hilt, to be a bad one for this country when it comes to a European war. It is true that it has placed a powerful means of striking at us in the hands of our present enemies, and that our efforts are being directed towards making ourselves independent of overseas supplies. It is equally true, however, that we are acting thus from military, and not from economic, considerations, and that military considerations in general are nearly always opposed to economic considerations. We do not doubt that the present intention of growing in this country all the grain we require is, as a war-time policy, a wise one. Under the circumstances in which the country is placed there is no safe alternative. But we do strongly doubt whether it would

be equally the best policy to adopt as a peace time provision against war conditions. We are certain it would not be so from the standpoint of economics. From the military point of view, we are of opinion that, as an alternative policy, the storage in the country of sufficient quantities of imported grain would be preferable were the choice open to us. It is not so open to us at present. After the war it will be, and with the aid of the engineer, the chemist, and the Government, we see no practical difficulty in the way of giving it effect. To indicate the extent of the undertaking we may illustrate what would be required in the case of wheat. It would be necessary to store a year's consumable supply at least—say, six bushels of grain per head of the population—and sufficient in addition to raise the second year's consumable supply, and seed for the third year—say, half a bushel per head. At 6½ bushels per head, this would entail constantly having in storage some 302 million bushels of wheat in the grain. There are several granaries already in this country—for example, the Meadowside granary at Glasgow—which are capable of storing well over a million bushels each. As a national undertaking, therefore, there is nothing in the suggestion which is impracticable.

CO-ORDINATION AMONG WELSH RAILWAYS.

During the last four or five months there have been occasional references in our pages as to closer working between the Taff Vale, the Rhymney, and the Cardiff railways, and on page 89 of our issue of August 3rd we gave some particulars as to changes in the management of these companies which, it was officially stated, would, it was believed, produce an improvement in the facilities, both at the important Bute Docks and the railways serving those docks. It was anticipated that the movement would have the most beneficial effect, not only upon the interests of the companies concerned and the traders of the district, but also upon the future and development of the city of Cardiff. That the scheme will not stop at centralisation of management is fairly certain, but no fusion of the companies is possible without parliamentary sanction. This, it may be remembered, was attempted in 1909, and some particulars as to what was then proposed and of the standing of the companies concerned may be of interest.

In the Bills deposited in 1908—there were two Bills, one for the vesting of the Cardiff Railway, and one for the vesting of the Rhymney—it was proposed to vest the undertaking of the Cardiff Railway in the Taff Vale Company, together with the Bute Docks and all canals, feeders, timber ponds, warehouses, pumping stations, and foreshore rights, &c., belonging to the Marquis of Bute and the Bute trustees. The Bill for absorbing the Rhymney Company was based on similar lines.

The Bills came before a House of Lords Committee, presided over by Lord Camperdown, in May, 1909; the Cardiff Bill was taken first. It was then stated that powers for constructing the West Bute Dock were obtained in 1830, and in 1840 the Taff Vale Railway, from Merthyr to Cardiff, with branches, was opened. In 1855 the East Bute Dock was opened, and in 1864 an Act was passed to extend the Rhymney Railway—formed in 1854—from Caerphilly to Cardiff. The Roath Basin was opened in 1874, and in 1882 the Roath Dock was authorised. In 1894 the Queen Alexandra Dock was authorised and opened in 1907. The delay in carrying out the last-named work was stated to have assisted in getting the Barry Railway and Docks sanctioned, where, it was remarked, in justification of proposals then being made, all the working was in the hands of one company. It was further stated that in 1857 an Act was passed containing sections which practically amounted to the amalgamation of the Taff Vale and Rhymney Companies. The Taff Vale Company itself and its undertakings were composed of thirteen separate undertakings, so that amalgamation had taken place to a great extent in that district, and not one of those undertakings, it was said, could have been successful if they had operated separately. For many years the Rhymney had desired to sell its undertaking, and overtures for this purpose were made as far back as 1882. In 1885 such a proposal was agreed to, subject to the Barry Railway having running powers, a suggestion which was unacceptable. In the Rhondda and Taff Vale Valleys the two companies had precisely the same kind of service. In 1906 the Marquis of Bute offered the docks to the Cardiff Corporation, but that body declined to have them. The Great Western Railway Company had other adventures to look after, and the only alternative therefore was the proposals made in the Bill then before the House of Lords' Committee.

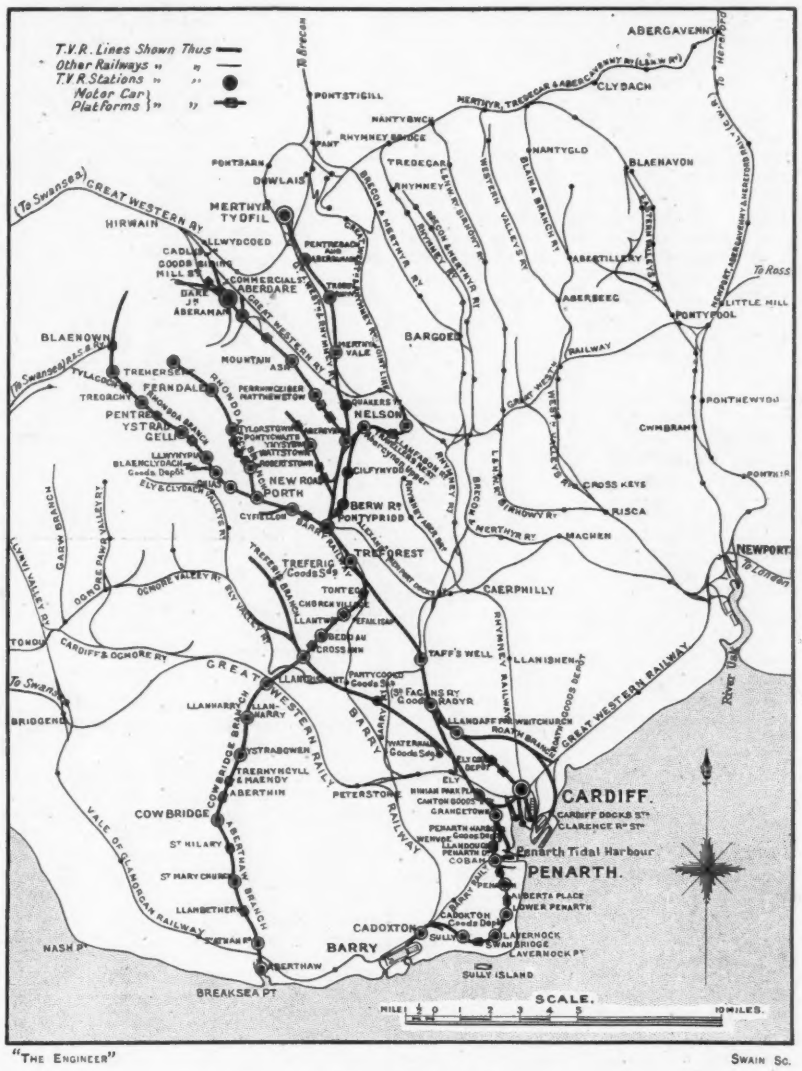
Mr. Beasley, then, and until quite recently, the general manager, but now the deputy chairman of the Taff Vale Railway, said that if the amalgamation was agreed to the Taff Vale Company would construct a junction with the Rhymney Railway near that company's Cardiff station, which would allow for the Rhymney trains to run into the Taff Vale station in Cardiff, and for some of them to proceed to the Great Western station, whence passengers could get to any part of the kingdom. Passenger trains from the Rhymney would also be able to obtain access to Cardiff Docks, which could not now be done direct. Passengers from Caerphilly would have another route—*viâ* Taff's Well—to Cardiff, whilst a short curve between the Rhymney Railway and the Taff Vale Company's Roath branch would give access from the former to the Queen Alexandra and the Roath Docks—a convenience not now possible.

At the time the engines of the Great Western, Taff Vale, Rhymney and Cardiff companies all took coal to the Cardiff tips. The three first-named were under statutory obligations to bring their traffic into the docks, and this was an obligation which could not be got rid of without the sanction of Parliament. It was always a squabble as to which traffic should be dealt with first. There was no such trouble at the Penarth Docks of the Taff Vale Company, nor at those of the Barry Railway Company at Barry; in both places all the working was in the hands of one company. At Cardiff no traffic could be sent into the docks without the sanction of one of the dock officials, and no one but the dock people knew to what tip the traffic was to be consigned. By the proposed co-ordination all the engine workings will be governed by the same person.

When the Bills of 1909 were before Parliament, Mr. Beasley said that he had given an undertaking to the Lord Mayor of Cardiff as to workmen's trains and fares on the Rhymney system; to take over the Rhymney servants; that no person should be disqualified for employment by reason of his belonging to a trade union; to give Rhymney servants the benefit of the Taff Vale pension scheme, which was more liberal as it did not require any payments by the men. He also undertook that if the railway workshops were subsequently concentrated outside Cardiff the workmen employed there would be allowed to reside in Cardiff and would be given facilities for getting to and from work.

The proposals were opposed by the Barry Railway Company and by the Alexandra Docks and Railway Company, also by several traders. The former company wanted running powers, but to this it was objected that there was not room for the Barry trains. On only 60 miles out of the 124 miles possessed by the Taff Vale Company was coal produced, and over these 60 miles there was, it was alleged, a heavier traffic than on any other railway in the world. There were some 73 collieries on that length, and the company had, on an average, one colliery junction to every quarter of a mile. To have another company running up that crowded line would, it was stated, be intolerable; very often 450 trains passed through Pontypridd every 24 hours.

The opposition of the Alexandra Docks Company was based on the fear that traffic from the Rhondda Valley, now going to Newport, might, in consequence of the Rhymney Company being no longer interested in its passage *viâ* Caerphilly, be transferred to Cardiff. The Alexandra Docks Company owned the Pontypridd, Caerphilly and Newport Railway, which commenced by a junction with the Taff Vale just south of Pontypridd, and joined the Rhymney at Penrhos. From the latter point there were running powers over the Rhymney to Caerphilly, where there was a junction with the Brecon and Merthyr, and running powers thence to Bassaleg, where the Alexandra Docks line was reached. This gave a direct route from the Rhondda Valley coalfields to Newport. In 1899 some 626,000 tons passed over the line, and some 908,000 tons in 1908. Practically all the coal from the Pontypridd end was delivered to the Alexandra Docks Company by the Taff Vale, which were in competition, and which wished to take the traffic to Cardiff or Penarth. The Rhymney had therefore a strong interest in fostering the traffic from Pontypridd, *viâ* Caerphilly, but would not have the same interest if the companies were combined. The answer of the Taff Vale Company to this was an undertaking by it that the agreement with the Rhymney as to running powers and rates should be made permanent.



RAILWAYS IN THE VICINITY OF CARDIFF

The two Bills subsequently passed the Committee in the House of Lords, but after a prolonged hearing in the Commons they were rejected; at least the Bill for the vesting of the Cardiff was rejected, and the Rhymney Bill was thereupon withdrawn. No explanation was given as to why the Bill was rejected, but the impression was that it was felt that too much power would be given to one company.

According to the annual report for the year 1913 the Taff Vale Company had a created capital of £8,395,777, of which £3,546,844 was nominal additions. The total expenditure on capital account was £6,554,385, of which £5,995,956 was on the railway, and £428,843 on docks. The total passenger receipts were £244,519; from goods traffic £721,660, and from docks £128,059. The expenditure on the railway was £575,569, and on the docks £76,620. The company had 176 tender engines, 75 tank engines, 18 steam motor car engines, 396 coaching vehicles, and 2252 wagons. The mileage of railway maintained was 124 miles 30 chains which, reduced to single track,

was 260 miles 20 chains of running line, and 140 miles 69½ chains sidings. The dividend on the ordinary stock was at the rate of 4 per cent.

The Rhymney had a created capital of £2,003,090, of which £267,488 was nominal additions. The amount expended on the railway was shown as £2,331,224. The receipts from passenger traffic were £98,636, and from goods traffic £295,293. The expenditure was £238,221. The company had one tender engine and 122 tank engines, also one rail motor vehicle, 140 passenger coaches, and 1091 wagons. The length of line maintained was 50 miles 49 chains, composed of 105 miles 43 chains single track running line, and 55 miles 63 chains of single track sidings. The dividend was at the rate of 9 per cent.

The Cardiff Company had a created capital of £5,362,100. Only £711,572 was shown as having been spent on railways, but on docks the amount was £5,976,959. The railway is, of course, a minor matter, and in 1913 it had an adverse balance thereon of £2665, but from the docks there were net receipts of £213,313—receipts £580,064, expenditure £366,751. The company had one tank engine, two steam rail motor vehicles, two composite carriages, and 43 wagons. The track maintained was 13½ miles in length, which, reduced to single track, was 22 miles running line and 1¾ miles sidings.

OBITUARY.

JAMES RYDER BUTLER.

We regret to have to announce the death, at the age of 75, of Mr. James Ryder Butler, founder of the firm of J. Butler and Co., machine tool makers, of Halifax, which took place on Sunday last.

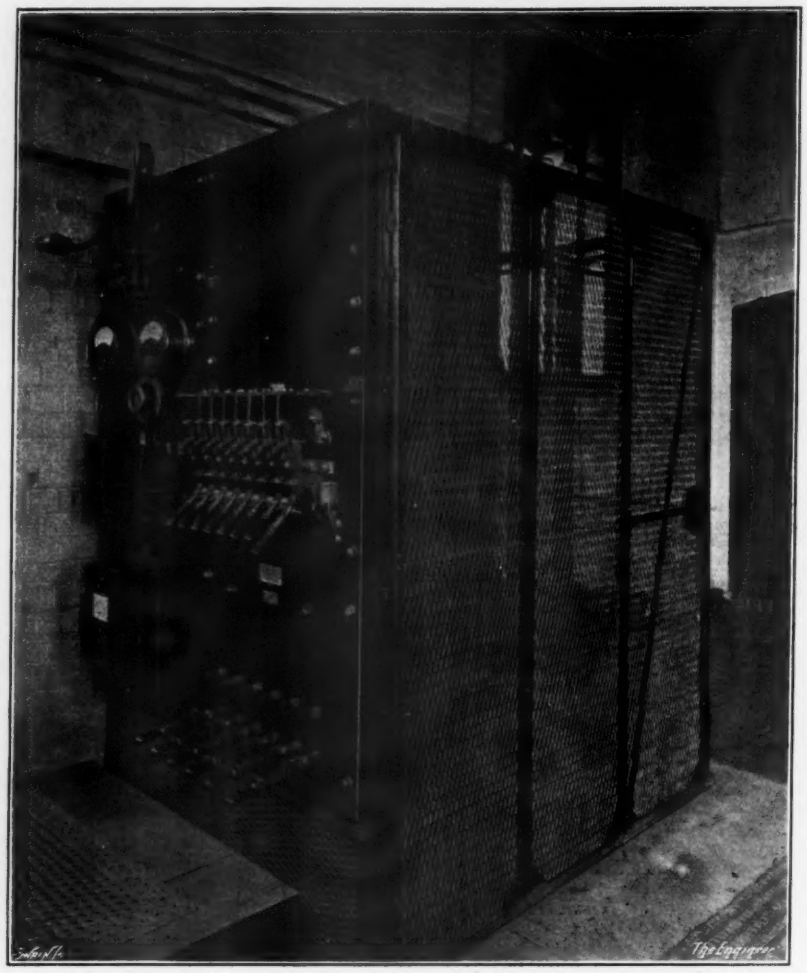
As a boy Mr. Butler was for a short time employed at the *Courier* office, afterwards working for the late Mr. Jonathan Jessop, chemist, Corn Market. Later, he was apprenticed to J. Crossley and Co., machinery makers, Bank Bottom. On completing his apprenticeship he was transferred to J. Crossley and Co., Dean Clough, going into the jacquard department, of which he subsequently became foreman.

He started in business for himself forty-eight years ago, in Weymouth-street, Halifax, specialising in the making of jacquards. Later he removed to a portion of Messrs. Farnell's (wheelwright's) works in Gibbet-street. In 1872 he entered into partnership with the late Mr. George Dennis, the firm being styled Dennis and Butler. The business was transferred later to Victoria Ironworks, which was built on what was then known as Half Mile Thorn Estate. After seven years the partnership was dissolved, Mr. Butler continuing on his own account in the machine tool business. In 1887 he took into partnership Mr. Henry E. Hodgson, and during this five or six years' partnership the first extension of Victoria Ironworks, including an ironfoundry, took place. After the dissolution of the partnership, Mr. Butler worked the business on his own account until he was joined by his two sons, Mr. Harold and Mr. Herbert. The extension of the business has been continuous, and frequent additions to the works have been necessary. Recently, the firm acquired Mile Thorn estate, containing about seven acres of land. The demolition of the ruined mill at Mile Thorn, and the commencement of new buildings, were a source of great interest to Mr. Butler. Though he had not taken an active part in the business for more than ten years, he had always kept in close touch with his sons.

Under Mr. Butler's guidance, and subsequently with the aid of his sons, the firm has made such progress that there are now about 500 employees. He was a past president of the Halifax Engineers' Employers' Federation, by the members of which he was held in high esteem. As regards his activities outside his immediate business, we may say that from 1892 to 1895 he was a member of the Halifax Town Council, being elected as the representative for Pellon Ward, and that, for a time, he was on the Council of the Halifax Chamber of Commerce. He was a greatly interested member of the Halifax Scientific Society, and was president of the photographic section, which had in him an enthusiastic supporter.

It is proposed shortly to establish a regular postal service by seaplane between France and the Island of Corsica. The following are the distances of the routes proposed :—Marseilles and Ajaccio, 200 miles ; Toulon and Ajaccio, 180 miles ; Nice and Calvi, 112 miles. From this, remarks the *Journal of the Royal Society of Arts*, it will be seen that there is no lack of choice for a suitable starting-place on the French coast, after a careful study of the winds and other atmospheric conditions. An Aerial Postal Service between Italy, Sicily, and Sardinia has already been established. The first post was opened on June 24th between Naples and Palermo, and three days later a service began from Civita Vecchia on the mainland to Terranuova-Pausania (Sardinia). In the first trip from Naples to Palermo a seaplane was used, carrying a heavy mail, flying at a height of 1500 to 2000 metres at 140 kiloms. (say, ninety miles) an hour, reaching Palermo in less than two hours and a-half. The service from Civita Vecchia to Sardinia was opened on June 27th by two seaplanes, each carrying 100 kilogs. of mail in water-tight bags. The passage was made in an hour and forty minutes, leaving Civita Vecchia at 6.20 a.m., and reaching Terranuova about 8 a.m., and the return journey was made in about the same time.

SWITCHBOARD FOR AN ELECTRICALLY-DRIVEN BAR MILL



AN ELECTRICALLY-DRIVEN 20-IN. BAR MILL.

An interesting case of the application of the electric drive in a steel works has recently been carried out for Johnsons' Iron and Steel Company, Limited, of West Bromwich, in an extension to the works, of which there is a new 20in. two-high bar mill which is electrically driven. The mill—of which a general view is shown in the upper view on page 186—consists at present of one stand of rolls—which is, we believe, eventually to be increased to two—for dealing with ball furnace iron and steel blooms. It is driven direct by a continuous current "Witton" motor—a view of which is given in the lower view on page 186—without any gear or ropes. The motor drives the mill direct, and a fly-wheel is interposed between the motor and the mill. The motor has been designed to give output of 300 brake horse-power on continuous rating at 52 revolutions per minute, and to an overload capacity of 100 per cent. for short periods. It is designed also for speed adjustment by shunt regulation from normal speed up to 100 revolutions per minute on light load, and is compound wound, in order to give a drop in speed of about 20 per cent. between light load and full load, so as to enable the fly-wheel to take a share of the load during heavy passes. So as to accommodate the motor to the particular requirements of various classes of work, a diverter is provided on the switch panel, so as to permit of the amount of compounding to be easily varied. In this way the drop in speed of the motor can be adjusted, and the fly-wheel can be called upon for a heavier or lighter amount of work.

The motor shaft runs in two pedestal bearings, and is connected by a flexible coupling to the fly-wheel. The fly-wheel shaft also runs in two pedestal bearings, one of which is carried on an extension of the motor bed-plate. The fly-wheel is 18ft. in diameter, and weighs about 20 tons. It is equipped with a band brake operating on the lower half, by means of which the mill can be brought rapidly to rest. The mill is driven from the fly-wheel shaft by means of a wobbler and disconnecting coupling.

To accommodate the electrical plant a wood paved motor house has been built. This house encloses the motor, switchgear, fly-wheel with its bearings, and overhead travelling crane, the crane rails being continued so that the crane can also travel outside over the mill housings, for which purpose the portion of the steel partition at the crane level is arranged to swing open. Two doors completely enclose the electrical plant from the dust of the mill, as shown in the engraving on this page.

The motor is controlled by a switch panel fitted with expanded metal sides and door. This panel comprises a double-pole main switch, circuit breaker, ammeter, voltmeter, kelvin—watt hour—meter, speed regulator, diverter for carrying the compounding, and multiple switch starter with grid resistances. The apparatus is interlocked by means of the special G.E.C. arrangement for rolling mills, which ensures the motor being started with full field, and the switches operated in the correct sequence. By the same device, the circuit breaker is prevented from being closed should the starter have been left in the running position.

The power for driving the motor is supplied by the West Bromwich Corporation Electricity Department. The electrical plant and fly-wheel was supplied by the General Electric Company, Witton, Birmingham, and Queen Victoria-street, London, to the specification of Messrs. Walter Dixon and Co., 38, Bath-street, Glasgow, the consulting engineers. We have to express our indebtedness to Messrs. Johnson for permission to take the accompanying photographs and to publish this description.

THE DEVELOPMENT OF MACHINERY IN THE UNITED STATES NAVY DURING THE PAST TEN YEARS.*

By Captain C. W. DYSON, U.S. Navy, Member.

(*Continued from page* 171.)

1906-1907.

During the summer of this year work was begun on the plans of our first two Dreadnoughts and for two, afterwards increased to five, high-speed destroyers.

The plans for the Dreadnought were prepared in competition with outside firms, and, while a nominal speed of twenty knots was provided in the design, sufficient reserve power was installed to ensure of twenty-one knots being attained.

When the competitive plans were examined by the department those prepared by the department were adopted and work on the contract plans and specifications at once started.

The machinery space provided in these vessels was such that only reciprocating engines or turbines of the impulse or impulse-velocity compounded type, similar to those of the Salem, could be installed. The department plans showed reciprocating engines designed on the same lines as those of the Michigan and South Carolina, the cylinder diameters as designed being 36in., 57in., and two of 76in., with a stroke of 4ft. The contractors, fearing a lack of power in these engines, later increased the diameter of the H.P. cylinders to 38½in., a change which was unnecessary for a speed of 21 knots, but which resulted in considerably higher speed of ship.

The plans also showed Babcock and Wilcox boilers fitted with superheaters, the superheating surface being 10 per cent. of the total heating surface. While in earlier vessels, in designing the boiler installations the empirical rule used had been 15 I.H.P. per square foot of grate surface and a ratio of 44.5 to 1 between heating and grate surface, in the design of these vessels the allowance was 18 I.H.P. per square foot of grate and a ratio of 44.5 to 1 between total heating surface, including superheaters, and the grate.

These dreadnoughts also marked our first step into the field of oil-fuel burning. When it was decided to fit these vessels with oil fuel the best system to adopt was not known. The entire field of oil burning was carefully gone over, and it was determined to fit them with that system

* From the *Journal* of the American Society of Naval Engineers.

which would require the fewest number of changes from the ordinary coal-burning installations, especially as in the case in view coal was to remain the principal fuel, the oil only being fitted as an auxiliary to be used when coal became difficult to trim or in emergencies. This requirement made it necessary to adopt a system with which the forced-draught blowers required by the coal-burning installation could be used, and we were therefore driven to the now well-known system of "mechanical atomisation," as it is called, although "pressure atomisation" would more exactly define it.

In the arrangement of furnaces for burning either coal or oil the grates are fitted as for ordinary coal-burning boilers, and the burners for oil, with the necessary slotted cones for the proper admission of air, are located between the furnace doors. Owing to the limited volume of the furnace between the tube roof of the furnace and the grates, only very limited quantities of oil can be successfully burned in such installations. The whole question of oil burning will, however, be discussed more fully later on.

Adoption of Turbines.

Before the advertisements for bids for these two dreadnoughts were issued the first turbine-propeller battleship, the British original Dreadnought, the name of which has been applied as a general name to the "all big-gun battleship," had her trials, and the results were spread broadcast as a world advertisement for this new form of propulsion. It is spoken of here as a new form for the reason that up to this period it had only been used for much smaller, less important installations in destroyers and in the small British cruiser Amethyst.

The installation on the Dreadnought was of the very simplest type, there being four shafts with high-pressure ahead turbines on two shafts and low-pressure ahead and astern turbines on the remaining two. There were no means whatever provided for increasing economy at low speeds, and the expenditure of steam at these speeds was extravagant.

The new type of machinery, however, immediately struck both the public and the service fancy, and the Navy Department, yielding to the clamour in favour of the new fashion, invited bids for turbine machinery in addition to those for reciprocating engines.

As previously stated, the engine-rooms on these vessels were too small to accommodate any other type of turbine than the impulse or the impulse-velocity compounded type. When the bids were received a satisfactory bid was made by the Newport News Shipbuilding and Dry Dock Company for one ship built according to the department plans and specifications, that is with reciprocating engines, while the Fore River Shipbuilding Company offered a satisfactory bid with guarantees of performance for a vessel with Curtis turbines.

The turbines offered were in general similar to those fitted in the Salem, but, inefficient and troublesome as they proved themselves later in actual service, they did mark one big step in the development of this now highly successful and economical American turbine, and the development of such a successful completed machine, in my opinion, completely justifies the early experiment and failure in the North Dakota. The improvement made consisted in increasing the turbine stages from seven to nine, the last four stages being carried on a drum in place of on separate stage wheels. This was the first appearance of drum construction with turbines of the Curtis and similar types, although it was and is the standared method for those of the Parsons type.

Until the advent of the Curtis turbine the Navy Department had been forced to go abroad for its turbine designs, a position which was extremely undesirable and which justified experiment to the fullest extent to relieve us of the situation.

Forced Lubrication.

During the building of the engines of the Delaware, reports were received of the results obtained with forced lubrication on the reciprocating engines of the British battleship Africa. These reports indicated such a great improvement over the ordinary method of gravity lubrication that it appeared desirable to incorporate it in the engines building. Plans were at once prepared by the Bureau of Steam Engineering and forwarded to the Newport News Company, with a request that the matter be taken up at once and an estimate for the cost of the change be submitted to the department in order that authorisation for the additional expenditure required for this improvement might be obtained. This was done and, after some delay, the necessary authorisation was obtained.

The original plans of forced lubrication for the Delaware contemplated applying it only to main and crank-pin bearings and to the excentrics, depending on the original gravity feed for lubrication of crosshead slides, wrist pins and valve-link bearings, and, in conformity with this idea, only those parts having forced lubrication were covered in by the oil casing.

When the vessel was taken out for her preliminary acceptance trials the crossheads and slippers showed a tendency to run warm, and, before the trials, temporary connections through the water-service piping were made from the forced-lubrication system to these parts. The results obtained due to the forced lubrication were very marked, practically all the vibration and noise to which we are accustomed with the ordinary system of oiling being noticeable by their absence.

The trials, however, demonstrated the desirability of extending the forced lubrication to all the moving parts of the engines, and also that, when extended to the crossheads and slides, a large amount of oil was thrown on the piston-rods and lower heads of cylinders, vaporising on the latter, the oil on the piston-rods and the oil vapour being drawn into those cylinders where pressures below the atmosphere existed. This oil then passed over to the boilers and caused fear of trouble due to the oiling up of the water side of the heating surfaces.

Development of the Piston-rod "Steam Seal."

The carrying of oil to the boilers being considered a serious menace, it was imperative that means to prevent it should be devised as quickly as possible, and in aiming at the preventive advantage was taken of the fact that for cylinders in which steam pressures lower than the atmosphere are apt to occur, the piston-rod outer packing must be designed to resist pressure from the outside. As the M.P. and L.P. cylinders are those in which this condition exists, and as the high pressures carried in the H.P. cylinders tend to cause a blowing out of steam along the piston-rod, cutting off the oil from the rod and preventing the entrance of oil vapour, it was necessary to apply the preventive to the M.P. and L.P. rods only. The cure finally adopted is now known as the "steam seal," and consists of an outer stuffing-box carrying about three rings of elastic packing with a space between the first or lower ring and the upper two, into which steam of a slightly higher pressure than that likely to exist in these cylinders is admitted. When the regular piston-rod packing is properly fitted and is operating properly the "steam seal" does its work efficiently. When the regular piston-rod packing is not doing its duty the steam seal may aggravate the trouble by blowing through into the cylinders.

In service this system of lubrication proved so satisfactory that little time was lost in extending it to quite a number of the older vessels of the fleet where equally satisfactory results have been obtained. One of the commanding officers of the fleet made the remark to me that we had builded better than we knew, as the reciprocating engine fitted with forced lubrication was quite a different machine from the same engine fitted with gravity feed. Only the other day a report was received in the Bureau from one of the armoured cruisers stating that they had just overhauled their crank-pin and main journals after a period of two years' running, and none of the bearings showed the slightest indication of wear. This, in itself, shows the immense decrease in work required to keep these engines in order over that required in the old days before forced lubrication was adopted.

Results of Trials of Delaware and North Dakota.

In the contracts for these two vessels appeared, for the first time, a requirement for the measurement of the steam used, this for the North Dakota being accompanied by guarantees that the following steam consumptions per shaft horse-power would not be exceeded:

Full speed	15.1 lb.
19-knot	16.1 lb.
12-knot	23.2 lb.

The Delaware's trials took place off Rockland, Me., in October, 1909, and those of the North Dakota off the same place in November of that year. The results obtained were:

Ship.	12-knot.		19-knot.		Full speed.	
	Del.	N.D.	Del.	N.D.	Del.	N.D.
Speed	12.24	12.04	19.217	19.21	21.56	21.64
I.H.P. (main engine)	3905	—	16,602	—	28,578	—
S.H.P. (main engine)	—	3757	—	16,713	—	31,862
Coal per I.H.P. or S.H.P.	2.673	2.64	1.795	1.63	1.888	1.71
Water per I.H.P. or S.H.P.	19.37	27.12	13.91	16.67	14.32	14.

In advertising the results of this first large Curtis turbine installation, the advocates of the turbine in comparing the two vessels religiously confined themselves to the comparison of coal per horse-power, and always called your attention to the fact that a shaft horse-power was only 92 per cent. of an indicated horse-power, and that, therefore, the fuel consumptions were:

	12-knot.	19-knot.	Full speed.
Delaware	2.9 lb.	1.95 lb.	2.05 lb.
North Dakota	2.64 lb.	1.63 lb.	1.71 lb.

per shaft horse-power, thus indicating the vastly greater economy of the steam turbine and its therefore much greater superiority as a marine engine.

They carefully neglected, however, to call attention to the following comparison, which gives the measure of the relative propelling efficiencies of the two types of machinery:

	Total pounds of water.		
Speed.	12 knots.	19 knots.	Full speed.
Delaware	83,463	243,810	422,931
North Dakota	101,883	281,784	445,979

These figures, which glaringly demonstrated the superiority of the reciprocating drive as compared to the then current turbine practice, have been maintained and even increased by the Delaware in service as the efficiency of the North Dakota's turbines rapidly decreased, while at the same time the turbines became unreliable, finally necessitating her withdrawal from active service with the fleet until new machinery could be built and installed.

Destroyers of 1906.

No torpedo boats or destroyers had been appropriated for since the completion of the first lot of sixteen destroyers, which had occurred in 1901-1902, these having been authorised in 1898, and having taken from three to four years for completion.

These original destroyers were of about 7500 I.H.P., and were designed for 28.5 knots trial speed. After many difficulties, and a reduction of trial speed to 27.5 knots, they were finally squeezed through and accepted. Great troubles were experienced with their light and fast-running reciprocating engines, and with their forced-draught blowers, which were also driven by reciprocating engines.

In 1906 and 1907 five more destroyers were authorised. The estimated I.H.P. for this speed was 10,000, and the Navy Department prepared plans showing Normand reciprocating engines for this power. In advertising for bids for the construction of these vessels bidders were invited to submit plans showing turbine machinery, both with and without cruising turbines, and were given to understand that, other things being equal, turbine installations would be preferred.

These vessels, as finally contracted for, were all of three-shaft Parsons turbine type, with a H.P. and I.P. turbine, one on each outboard shaft, for cruising purposes. The vessels were all coal burners, and while, during their construction, it was proposed to change to oil fuel, the cost of change and the difficulties in the way due to progress of construction were found to be so great that the idea was abandoned.

There never was any doubt in the mind of the department as to the desirability of displacing the unreliable high-speed engines that had been previous practice for these light high-speed vessels by the more reliable turbine, and the step was taken with no hesitation. There was also another step in advance made at the same time, and this step was even of more value, if possible, than the adoption of steam turbines for the main propelling engines.

Steam Turbine-driven Blowers.

One of the great sources of failure to hold high speed for any long continued period of time with all classes of vessels had been the continually recurring breakdowns of forced-draught blowers with engines of the reciprocating type. These had been done away with, and blowers driven by electric motors substituted for battleships, beginning with the Michigan and South Carolina, as already stated.

In two of these five destroyers appeared, for the first time, the turbine-driven forced-draught blower. In laying down the plans for these vessels the Bureau of Steam Engineering had scanned the market closely to find turbine-driven blowers of proper design to install for the work required. Not being able to find any such in existence, it invited in the specifications the installation of such type in place of the type directly specified. Meanwhile it succeeded in awakening the interest of the Terry Steam Turbine Company in the proposition, and by the time the contracts for the construction of the vessels were awarded, this company had developed what appeared to be, on paper at least, a very satisfactory unit.

The Cramp Ship and Engine Building Company were quick to see the advantages in this new unit, and proposed its installation in the two vessels building by them. This proposal was approved, and the units installed. The contractors for the remaining three vessels, however, adhered to the old reciprocating-engined blowers, arguing the greater steam cost with the small, inefficient turbines, losing sight, however, of the fact that with feed heaters installed and with turbine main engines in which excess auxiliary steam can be used in the heaters and in the low-pressure stages of the turbines, steam economy of auxiliaries only used when the main engines are in operation or used to only a small extent in port, does not cut any great figure in the general economy of the machinery plant. Also that the greater reliability of the turbine blowers would, if realised, more than offset any possible loss in economy, as the forced-draught blowers, in rate of importance to a destroyer, are as necessary as a good heart is to the human body.

The blower units as fitted were of the vertical, direct-connected turbine type, with single-stage Terry turbines, driving what are known as multivane fans of the Sirocco type. These fans are located directly at the base of the intake ventilators and discharge throughout their complete circumference into what is called a diffuser chamber, in which the velocity of the discharge becomes reduced and the air pressure after discharge from the fans increased.

The diffusion chamber is formed by two plates forming frustrums of cones with the bases separated several inches at the outer circumference; the inner edges of the plates at the fans being separated to the width of the fan blades.

When the vessels carrying the new type of blowers were tried great trouble was experienced due to two fans discharging into the same fire-room; unless the fans were running at practically the same speeds, that fan which was doing the least work would be wrecked on account of the air being forced back through it. After considerable trouble and experiment the cause of the trouble was located. It was due to the too great width of discharge opening from the diffuser chamber. This error was corrected and the fans by their later performances installed such confidence that no other type of blower than that of the turbine driven has since been considered for destroyer work, and in later vessels of other types it has even shouldered the electric-driven fan out of the way, as the flexibility of control is so much greater.

Experience with Oil Fuel on the Delaware and North Dakota.

The oil-fuel handling of these two vessels varied in one respect, and that was in the location of the settling tanks, that of the Delaware being located aft alongside the engine-room, while the North Dakota followed the Bureau plans, and had a small cylindrical tank located in the upper part of each fire-room. This location on the North Dakota was later credited with a disastrous fire on that vessel, in which several lives were lost. The real cause of the disaster was, however, the fact that each of these tanks was fitted with a glass gauge for indicating the height of oil in the tank, and oil vapour having collected on the flat tops of the B. and W. boilers, it became ignited in some unknown manner, the flash resulting broke the gauge glass and, the booster pump supplying oil to the tank being running at the time, the oil was forced out, and burned like a gigantic torch until the pump was stopped, and the tank completely emptied.

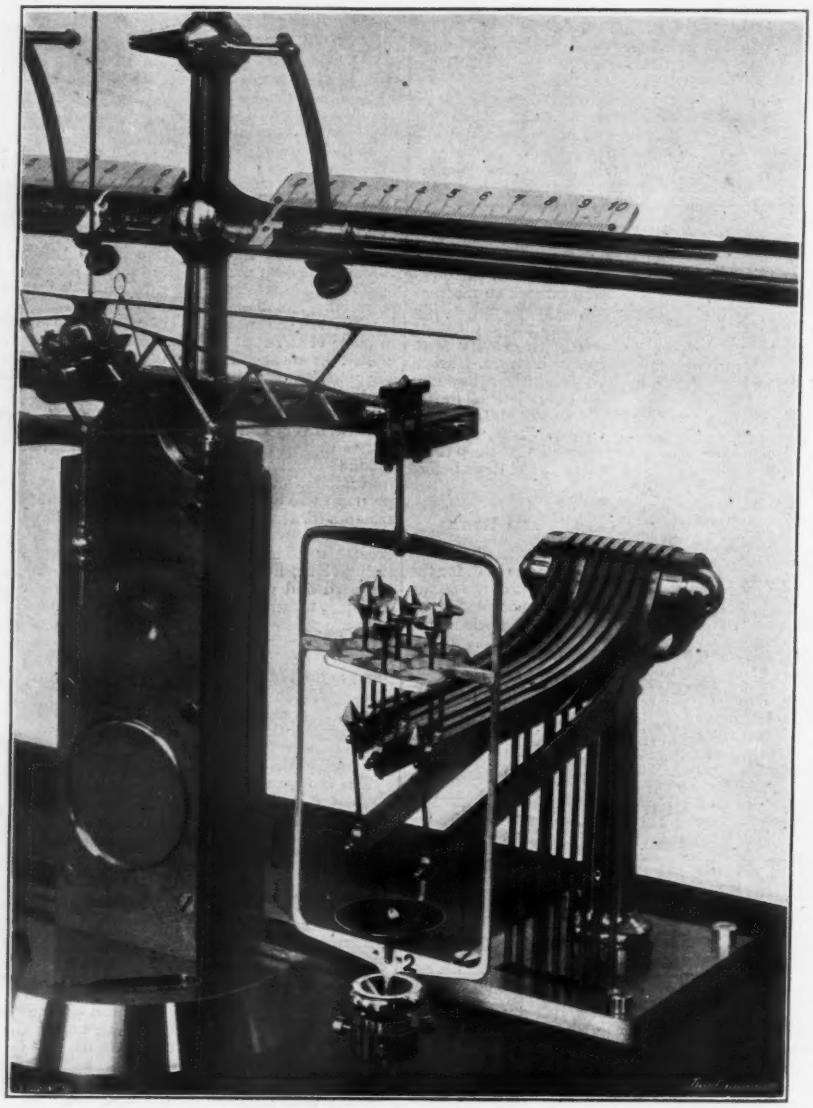
Orders were immediately issued by the department prohibiting the use of gauge glasses on oil-fuel tanks unless such glasses were fitted with spring valves that were open only while readings were being taken, the valves closing automatically when released.

Other troubles were experienced with the oil fuel due to the inexperience of all hands concerned with it, including the makers of the oil-fuel apparatus. The burners as originally supplied were of sufficient capacity to deliver the full power condition, and this, on account of insufficient volume of furnace above the grates, resulted in heavy carbonisation on the grates and bridge walls and in very heavy smoke formation. All manner of criticism was levelled at the system employed, and it was only by taking strong stand on the subject that the Bureau prevented it from being superseded by air or steam atomisation. The succeeding years have demonstrated the wisdom of the step, and we hear no more of propositions to use any other system.

(To be continued.)

The Indian Railway Board has sanctioned a survey by the Eastern Bengal Railway of the left bank of the Jamuna River for a site in connection with the ferry service on the proposed Serajganj-Mymeneingh Railway.

ASSAYING AND CHEMICAL BALANCE



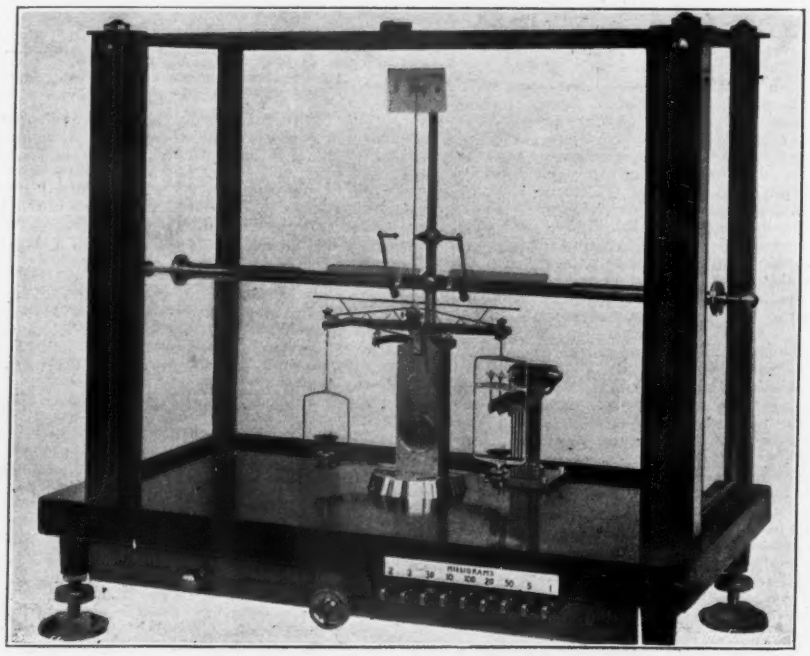
A NEW FORM OF BALANCE.

An interesting type of balance for assaying and chemical analysis work, made by Mr. Wilfrid Heusser, Salt Lake City, Utah, is illustrated in the accompanying engravings. With the ordinary type of balance a considerable amount of time is wasted in applying the smaller weights, say, those below a tenth of a gram. The operation of lifting these small weights by means of tweezers, applying them to the weight pan and removing them if not correct, is not only tedious; it is also a matter requiring for its successful achievement a fair amount of manipulative skill. One of the features of the balance illustrated is an arrangement of parts whereby the smaller weights—namely, in the case shown, those extending from 100 down to 1 milligram—are applied to the balance in a more or less mechanical manner. The actual individual weights provided are 1, 2, 3, 5, 10, 20, 30, 50, and 100 milligrams. With these nine weights it is possible to make up any number of milligrams from 1 to 221.

The weight pan hanger, as shown above, carries near its top a bridge piece provided with nine countersunk holes arranged on three diagonal centre lines. A pillar rising from the surface of the instrument base towards the rear carries nine corresponding levers, each of which is provided at its outer end with a rod having a conical tip. On these conical tips are supported the nine weights which take the form of perforated metal discs. On lowering any one of the nine levers the rod and its cone pass clear through to the underside of the bridge piece leaving the weight behind within the countersunk hole. On raising the lever again the weight is lifted on the coned end of the rod into the out-of-action position. The levers are operated by means of nine keys at the front of the instrument base. The application and removal of the small weights can thus be effected, even by an unskilled person, in a speedy and delicate manner.

The pan for the major weights is, as shown in the engraving above, supported from the pan hanger on a three-fingered carrier, which ensures the pan always being situated centrally. The central column of the balance is supported on a circular base into which two small spirit levels are sunk. The column is hollow and contains a vertical rod which, when raised by means of the knob at the front of the base, relieves the weight on the knife edges at the centre and ends of the beam. Two cross bars are fixed directly to the vertical rod. The upper one of these lifts the pan hangers off the knife edges at the end of the beam. The lower one is provided with a cup-shaped member at each end. These cups when they rise engage with a pin formed centrally on each hanger directly beneath the pan, and so prevent the hanger and pan from swinging. This feature is of assistance when the pans are being loaded preparatory to a weighing operation. The rise of the vertical rod also operates a third cross bar, pins in the end of which engage beneath the beam and lift it clear of its knife edges. There is a small amount of lost motion in the rise of this cross bar, so that the rise of the beam may be a small amount less than the rise of the hangers and pans.

Every effort has been made to keep the beam as light as possible, for on the weight of this part, it is urged, the sensitiveness of the balance largely depends. The beam is formed with a horizontal bar for the usual rider whereby the fractional parts of a milligram may be applied to the balance. To keep the weight of the beam as low as possible the position of the rider on its bar is not, however, measured, as is usual, against a scale fixed to the beam itself, but against an entirely independent scale on a tube running from side to side of the casing and fixed mid-way to a vertical support. This tube is cut open at the point where the scale is fixed to it, and contains a rod provided with an arm whereby the rider may be lifted and moved along the rider bar. A pointer fixed to the arm end of the rod allows the position of the rider to be read against the scale. A similar arrangement is provided on the opposite side of the central support, so that the balance may be adjusted either by the addition or subtraction of fractional parts of a milligram.



BALANCE WITH MECHANICAL MEANS OF APPLYING SMALL WEIGHTS

MINERS' WAGES.

The Executive Committee of the Miners' Federation of Great Britain met the Controller of Coal Mines on Tuesday last, and put before him a request for an increase of 25 per cent. on present earnings. Mr. Smillie, the President, and Mr. Herbert Smith, the Vice-President of the Federation, stated the grounds on which the request was based. The Controller undertook to lay the matter before the Government, and to communicate the result to the Secretary of the Federation at the earliest possible moment. It was reported that the miners in one of the important Midland areas were at present working out their notices, and threatened to come out on strike unless an immediate advance in wages was given. The Controller of Coal Mines and the Executive of the Miners' Federation expressed the hope that no action of this kind would be taken until the Government had had time to consider the application put forward on Tuesday.

TINPLATES AND TERNEPLATES.

The following Order has been made by the Minister of Munitions, under the date of August 24th, applying Regulation 30A to tinplates and terneplates:—

In pursuance of the powers conferred upon him by Regulation 30A of the Defence of the Realm Regulations the Minister of Munitions hereby orders that as from the 19th day of July, 1917, the war material to which that regulation applies shall include war material of the following classes, that is to say:—Tinplates, terneplates.

The following notice was also issued at the same time:—

With reference to the above Order applying Regulation 30A of the Defence of the Realm Regulations to tinplates and terneplates, the Minister of Munitions hereby gives notice that the General Permit of the 1st November, 1916, under the Orders of the 7th July and 31st October, 1916, shall as from the 19th July, 1917, take effect as if the war material referred to in the above Order were included in the Order of the 31st October, 1916, and the following materials and prices were specified in the schedule to the said General Permit, provided that Condition 2 of the said General Permit shall not apply to any sale or purchase of the war material referred to in the above Order of this date under a contract in writing entered into prior to the 19th day of July, 1917, and that the proviso contained in the said Condition that such Condition shall not apply to any sale by a manufacturer of finished steel rolled from steel purchased by him, or to a sale or purchase of material the export of which has been duly sanctioned, shall not apply to any sale or purchase of the war material referred to in the above Order of this date, provided also that nothing herein contained shall affect or prejudice the provisions of the Order of the Minister of Munitions as to control of steel supplies dated the 20th November, 1916.

Maximum Prices for Tinplates and Terneplates.—With the exception of Staffordshire tinplates.—Per basis box net f.o.b. makers' works or nearest station:—

Coke tinplates: I.C., 20 × 14, 112 sheets, 108 lb., 30s.;

D.C., 25 × 17, 50 sheets, 94 lb., 29s.; S.D.C., 22 × 15, 100 sheets, 163 lb., 45s. 6d.; 28 × 20, 30 × 21, 19¼ × 14, 18¾ × 14 at basis price for 20 × 14. These prices are based upon tin at £240 per ton; for each rise or fall of £5 per ton above or below this figure, 1½d. basis to be added to or deducted from the basis price of the tinplates. No alterations of tinplate prices are to be made for lesser fluctuations than £5 per ton in the price of tin. In all cases in which the maximum prices hereunder are expressed to be based upon the price of tin, the price of tin shall be the official cash settlement price of the London Metal Exchange for standard tin—as published on the day that the quotation is made by the seller. List of extras and allowances are all net, and for 112 sheet boxes, excepting in the cases of doubles and small doubles.

Extras for Basis Box (where not otherwise stated) over the Price of Coke Tinplates.—Small lots: Any size ordered in quantities of less than 2 tons, 6d.; common charcoal tinplates, 1s. 0d.; charcoal tinplates, through flux, tin per basis box, 3 lb., 3s. 9d.; 3½ lb., 5s.; 4 lb., 6s. 3d.; 4½ lb., 7s. 6d.; 5 lb., 9s. These extras are on the basis of £240 per ton for tin; adjustments of prices for fluctuations therefrom to be made by adding or deducting the value of the tin, according to the coating of the plate. The above prices are not to be varied for lesser fluctuations than £2 10s. per ton. Crosses (in all qualities), each cross, 7s.; intermediate weights to be charged *pro rata*, thus, 122 lb. substance will be 3s. 6d. basis extra over I.C. substance. Ordinary stamping steel, 3d.; special deep stamping steel, 9d.

Odd Sizes. Basis Extras. Over 24in. Long.

Width.	Length. Over 24in. to 32in., inclusive.	Over 32in. to 34in., inclusive.	Over 34in. to 40in., inclusive.
	s. d.	s. d.	s. d.
10in. to 12in.	0 9	1 0	1 3
Over 12in. up to 17in., inclusive ..	1 0	1 3	1 6
,, 17in. ,, 18in. ,, .	0 9	1 0	1 3
,, 18in. ,, 22in. ,, ..	0 6	0 9	1 0
,, 22in. ,, 23in. ,, .	0 9	1 0	1 3
,, 23in. ,, 24in. ,, .	1 0	1 3	1 6
,, 24in. ,, 26in. ,, ..	1 6	1 9	2 0

24in. Long and Under.

Width.	Length. 24in. long.	Under 24in. to 23in.	Under 23in. to 17in.	Under 17in. to 12in.	Under 12in. to 10in.
	s. d.	s. d.	s. d.	s. d.	s. d.
10in. to 12in., inclusive	0 9	0 6	0 6	0 9	0 9
Over 12in. up to 17in., inclusive ..	1 0	0 9	0 6	1 0	—
,, 17in. ,, 23in. ,, .	0 9	0 9	0 9	—	—
,, 23in. ,, 24in. ,,	1 0	1 0	—	—	—

Extra for boxes of 56 sheets, basis, 1s.; extra for boxing small sizes in 112 sheets boxes, this extra being applicable only to small sizes that are customarily packed in boxes of 225 sheets or thereabouts, basis, 9d.; extra for boxing doubles, 34 × 25, 25 sheets per box, 1s.; special boxing not covered in list to be based on actual cost.

Tissue papering at cost. Ironhooping, 20 × 14 and under, 3d. per box; over 20 × 14, 3d. basis. Clipping, 2d. per box, all sizes. Tin lining, 20 × 14, 112 sheets and smaller sizes, 1s. 3d. per box; 20 × 14, and smaller sizes packed 225 sheets, 1s. 4½d. per box; over 20 × 14, 1s. 3d., basis extra. Special plates for milk required to be tinned with list on long side, such as 25⅞in. × 9⁷/₁₆in., to carry a special extra of 1s. basis. Taggers, sizes larger in area than 20 × 14 of 40 g. = 300 sheets, 20 × 14 × 112 lb. and thinner substances, 1s. basis, 20 × 14 × 112 sheets. This extra will apply to 28 × 20.

Allowances to be Made per Basis Box Below the Price of Coke Tinplates.—Lights: Reduction of ¾d. per lb. basis for each pound down from 108 lb. to 80 lb. substance, and ¼d. per lb. basis reduction for each one pound down thereafter, including taggers. Unassorted, 1 X substance and thinner, 1½d.; thicker than 1 X, 3d.; wasters, 2 X substance and thinner, 1s.; thicker than 2 X, 1s. 6d.; charcoal wasters, per basis box below the price of charcoal tinplates, 1 X substance and thinner, 2s.; thicker than 1 X, 3s.; packing in bundles instead of boxes, 6d.

Maximum Price for Terneplates.—28s. per basis box, *i.e.*, 2s. below the basis price of coke tinplates. This price is based upon tin at £240 per ton; for each rise or fall of £20 per ton above or below this figure 1½d. basis to be added to or deducted from the basis price of the terneplates. All other extras and allowances are for coke tinplates.

Waste Waste Tinplates and Waste Waste Terneplates.—At not less than 2s. basis below the prices for waster tinplates and terneplates respectively.

To the maximum prices and extras for tinplates and terneplates, a sum not exceeding 2 per cent. on such prices may be added in the case of sales made by persons other than the makers or their agents, plus the actual cost of delivery from works to destination.

In the case of dealings between merchant firms it is not permissible for each of them to add such 2 per cent., as in no case must the cost to the ultimate consumer be beyond 2 per cent. over the said maximum prices, plus carriage charges.

Merchant stock holders delivering from their own warehouses—not public warehouses—are permitted to sell from their stock at the maximum prices, plus the maximum addition of 7½ per cent. on such prices, exclusive of inwards and outwards carriage. This 7½ per cent. will include the merchant's commission of 2 per cent., and is not in addition thereto.

All communications with reference to the above shall be made to the Director of Steel Production, Ministry of Munitions of War, Whitehall-place, London, S.W. 1.

NOTE.—All plates of any sizes bought against stock permits and unsold at July 19th, 1917, are subject to the conditions as to prices and otherwise imposed by this notice. All sales and purchases whether for home or export trades on and after July 19th, 1917, are subject to the said conditions.

NEW METHOD FOR DISCHARGING ORE.

THERE is at present in operation at Clydebank a method of discharging ore cargoes which is a distinct advance on the present practice at that place in dealing with vessels carrying cargoes of mineral ore. The new departure has been rendered possible by the introduction of the Donaldson Elevator, a novel type of "digger" designed to discharge at the rate of 120 tons per hour. This elevator, which is capable of adjustment to any hatch, and works all parts of the hold, consists of an endless belt of bucket diggers which are let down into the hold. The buckets, as they reach the top of the elevator, tip over and discharge their contents into a shoot, which leads on to an endless belt travelling over the side of the ship on to the railway wagons on the quayside.

The elevator is practically self-filling, only an occasional man being required to see that the ore is running to the buckets. The buckets are fitted with a spring support to enable them in the case of a very lumpy ore to knock aside unwieldy lumps and thus prevent the mechanism being knocked out of order. The loading belts are suspended by block and tackle, and are capable of being easily raised or lowered to any desired position. The elevator is electrically driven, and, running easily, discharges the ore from the hold to the wagons in a steady stream without interruption. The driving platform is attached to the girder framework, and commands a view of the entire operations.

When fully extended, the machine carries thirty-three digging buckets, and can reach the bottom of the deepest hold with ease. Mr. Donaldson, the inventor, is sanguine that four of the diggers working at four hatches will be able to discharge a cargo of 4000 tons in one day, only a minimum of labour being employed.

THE CHANNEL TUNNEL.

WE have been asked to publish the following:—

The announcement made in the House of Commons by Mr. Bonar Law, in reply to Mr. Arthur Fell's question, on the 16th inst., has disappointed, but not surprised, the supporters of the Channel Tunnel. On the contrary, they recognise that, in the circumstances, it would have been difficult, at the moment, for the War Cabinet to have come to any conclusion other than that indicated by the leader of the House.

Those who wish to promote a Bill for linking up the South-Eastern and Chatham Railway in England with the lines of the Chemin de Fer du Nord in France have, however, no intention of deferring beyond the end of the war the project, which is now more earnestly advocated than ever, not only in the United Kingdom, but also in France, Italy, Switzerland, and Belgium. To-day the proposal stands upon a stronger basis than at any previous period, especially in view of the significant lessons taught during the last three years, and there is every reason to believe that, when the war is over, the undertaking will be approved, and work commenced thereon with little delay.

Shortly after the reassembling of Parliament, Mr. Fell, as chairman of the House of Commons Channel Tunnel Committee, will seek an opportunity for the discussion of the subject, and, if possible, for a division to be taken upon the motion of which notice has been given.

POWER PLANT EXTENSION IN CALIFORNIA.

A FORCE of some fifteen hundred men is at present engaged on an interesting piece of work in the heart of the Sierra Mountains, California, at 7000ft. above sea-level. There is need for speed, for the work must be completed between snow and snow, not a long period in that locality. The work in question is a power development by the Southern California Edison Company, of Los Angeles, 240 miles away, which serves 10,000 square miles, and a population of 750,000 people Three concrete dams, 120ft. high, were constructed four years ago, and two power plants of 40,000 horse-power each were installed. The dams are now being built 35ft. higher, which will double the present storage capacity of the reservoir, known as Huntington Lake, and will increase the investment to 14,000,000 dol., say, £2,800,000. Ultimately, the project will produce 350,000 horse-power. This is a greater power development than that of the famous Keokuk dam, on the Mississippi River. The Mississippi falls 23ft. in 12 miles. Big Creek, in the Sierras, has a fall of 4000ft. in six miles. It has a drainage basin of 88 square miles, a rainfall of 80in., and a run-off of 50in.

In the California project the water is led through a tunnel and steel pipe lines to the first power-house, some half-way down. At this point the static head is 2100ft. From there it escapes into a creek, which is blocked by a fourth dam, and is diverted into a second tunnel, four miles long, and through a long series of conduits to the second power-house. In each power-house are two main generators of 17,500 kilowatts each. The electric current is generated at 6600 volts, and raised to 150,000. Its distribution requires 5,000,000 lb.—say, 2232 tons—of aluminium cable.

A 56-mile railway had to be built in 157 days in order that the project could be carried out. This railway, known as the San Joaquin and Eastern, is now operated as an independent commercial undertaking between Fresno and Cascada, a summer resort in the lake district.

This unique railway claims, says the *Earth Mover*, of Aurora, Ill., from which the particulars contained in this article are quoted, to be the crookedest road in the world, and there seems to be no good reason for disputing the fact. It has a curvature amounting to 120 complete circles.

THE Queen's Hotel, Birmingham, of the London and North-Western Railway Company, has, after three years' work, been considerably extended. The bedroom accommodation has been doubled.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

September and the Iron Trade.

ALL descriptions of iron and steel, except sheets, are still wanted in larger quantities than productive resources are equal to. September starts with many orders being rejected, and in other cases sellers cannot bind themselves by hard and fast conditions as to delivery. Government requisitions are frequently interposed to the delay of private contracts, and there is less and less chance for any work to be carried through which does not command the primary certificate. The bar iron makers have the largest list of orders, and there is a continuous demand for stamping sheets and wide strips and hoops. Makers of angles, small rounds and ovals are severely pressed to send on their production for consumption. Merchants report an active demand, and are unable to provide stocks in the warehouses for small deliveries. Owners of bar mills have as many orders on their books as will suffice to keep some departments going up till the end of the year. In other branches they are only able to maintain a certain amount of freedom by declining to entertain new business unless it falls within imperative categories.

Bar Iron and other Prices.

Bar makers report that they are extremely well sold. Demand is not running to any appreciable extent on "Crown" qualities. From the makers' point of view it is rather a good thing that it is not, for there is now no profit in the £13 fixed by the Ministry of Munitions. The price is now well over a year old, and since it was fixed pig iron and fuel have both advanced appreciably, and so have other raw materials, while there have been several increases in wages. If makers' activities were confined to this class of material they would be a great deal out of pocket. Happily they find a very good demand for special qualities for which no limit is fixed. Prices in the respective branches are very firm. Such is the demand for marked bars that offers range at from £15 10s. to £17 per ton. Sales of common bars are reported at from £14 10s. to £16. Hoops and rods are £18, iron is £20, best thin sheets are £24, and black sheets are worth £19 10s., though the galvanisers are restricting their dealings. There is an outcry for puddled bars at £10 10s., and some makers will not sell under £12. The demand for finished black plates is greater than the supply. Consumers say they cannot obtain wasters except at premium terms, and that if they comply with these trouble is entailed in filling up forms, and they are not able to execute their bargains in the periods stipulated.

Sheet Iron Prices and Government Action.

Negotiations are in progress for the application of price control to the sheet iron trade. Circumstances have already conduced to give the Ministry pretty large control, for supplies of raw material have been strictly regulated, and at the other end the export trade has been subject to rigid restraints. Last month shipments of black sheets amounted to 19,730 tons, while the export business in galvanised sheets had shrunk to 1285 tons. The Midland sheet iron makers have suffered more from the war than any other department of the iron and steel trade. The incidence of dead charges is necessarily very onerous owing to the large amount of unutilised productive capacity. Values have, however, been noticeably steady for a long time past. A year ago prices were still rising, and between July and October the quotation for black sheets advanced from £18 to £19. It has remained at £19 10s. for a period of nine months, while galvanised sheets have stood at £28 10s. and upwards. The number of idle plants has gradually increased, and the recent holiday marked the closing down of some additional galvanising departments. Output has been confined to orders carrying the "A" Certificate. For some little time the question of fixing a maximum price or prices has been under discussion, and it is now understood that a definite announcement may be expected almost directly. The figure suggested by the authorities, I may say, is one which the trade does not regard as meeting the fairness of the case.

Basic Pig Iron and Government Price.

The further measures taken by the Ministry to hasten the output of more basic iron are expected to yield tangible results within a very short time. Derbyshire and Northamptonshire furnaces have now been provided with the necessary new plant and will get to work forthwith. It is said that important enterprises are contemplated in Staffordshire. During the transition period there is likely to be some iron of a high quality—but not of the grade eventually aimed at—available for the market. There are complaints that the price allowed by the Government is not sufficient to cover costs and to leave a satisfactory margin of profit. There is a difference of about 10s. per ton in selling price between basic and foundry iron, which is regarded as insufficient.

Steel Scarcity.

The scarcity of steel continues to increase. One effect is that all contracts are being closely scrutinised by the Ministry of Munitions, and a careful selection made of orders regarded as imperative to the exclusion of work which a short time ago was classed as war work. General orders are pushed further to the rear. All works have bookings sufficient to cover their productions for several months. The scarcity of American billets has turned a certain amount of business into the puddled bar departments in cases where iron can be substituted for steel. There are considerable inquiries for structural steel in connection with the erection of new works and extensions. Although steel is specified iron has to be substituted unless Government officials assist to provide supplies. Soft steel sheet and bar orders are returned. A like condition is reported for steel plates. The chief deliveries of discarded billets are from South Wales, and some consumers report that there is a great deal of waste in rolling these

down. So short are steel consumers in the Midlands of semi-manufactured bars and billets that an appeal is to be made to the Government to allow the shipment of billets to this side along with the American cotton crop, which has been purchased for shipment to Great Britain. Consumers would gladly pay from £12 to £14, delivered, for the material, and it is hoped that the representations which are to be made will be successful. Native steel bar discards are commanding £11 to £12 delivered Midlands.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE iron and steel market remains in a somewhat uninteresting condition, and the attendances on the Manchester Exchange are still very small. No improvement is to be noted in the supply of finished iron and steel, and beyond the mechanical distribution under Government control very little can be done. There is no further news from America as to the prices which are, presumably, to be fixed there, and no American material of any sort is coming on this market, unless perhaps a small lot or two of wire rods at about £30 per ton. The anxiety about the supplies of Spanish ore is somewhat relieved by the news that the revolutionary movement has been put down in that country; but, of course, it does not quite follow that the strikes will cease even if the Spanish Government has obtained the upper hand. This question, however, affects hematite more than common iron, and in Manchester we are fast losing all interest in hematite iron. Even in cases where it was recently considered indispensable for certain foundry work, people, under the stress of necessity, are beginning to find substitutes; and in one instance of which I know steel scrap has been employed where a few months ago the idea would have been regarded with horror. The present prices are looked upon as stable for at least another six months, and people are free to act accordingly. The high prices, however, militate against general industry, and delay any return to ordinary work, even if the machinery of the country were free to deal with it.

Foundry Iron.

Reports from the Cleveland district indicate that there is still an abundance of No. 3 iron to be had, and as the price for export is fixed at 10s. above that for home consumption, it is fairly clear that the facilities for export are very much restricted. Probably it is the lack of shipping which prevents makers of the North Country iron from taking advantage of the export price, and getting rid of all the surplus; but this is a good thing for the Lancashire founder, who was a little anxious some few weeks ago lest the supplies of Midland iron should not be sufficient. Cleveland iron does not yet come to Manchester to any extent, but it can save Derbyshire up in the North, and this is a very important point. Sellers of Derbyshire No. 3 still quote 98s. 8d., and Staffordshire is offered at 102s. 6d., but the amount of business which is passing is comparatively small. A little Northamptonshire is on offer at about the same price as Derbyshire. The falling off in the volume of business in foundry iron during the last month does not give rise to any anxiety, and it is fairly evident that makers are too well sold to be worrying yet as to the future. There is no competition, and no pressure to obtain fresh orders. The tendency on the part of consumers is to buy small lots and to buy more frequently, for they see no particular reason to make the usual forward contracts, even although they may have work on their books which will require the iron. If there were any probability in their minds of a higher range of prices no doubt they would then buy more freely. This hand-to-mouth buying makes business less profitable than it should be, but there would appear to be no help for it until the markets are again freed from restrictions. Some small business has been done in Scotch iron lately at the official rates.

Forge Pig Iron.

A moderate business only is being done in forge pig iron, although one would say that a much larger supply of this class of iron is needed in Lancashire. Possibly the forges might be unable to deal with it, owing to a lack of labour, but if so then labour of the right kind should be provided by the Government; for an increase in finished iron production is one of the things which is urgent at this time.

Scrap.

The demand for steel turnings is very curiously on the increase, and higher prices were offered from Sheffield. For months past the consumers of steel scrap in that centre have been steadily refusing to pay the maximum price for ordinary heavy melting scrap, and, in fact, their ideas of the value of this material have been altogether impracticable. Now they concentrate their attention on turnings, of which large quantities are being made in Lancashire. The limit fixed by the Ministry of Munitions for ordinary turnings is 50s. on trucks; but for special heavy turnings 70s. is allowed. A large proportion of the turnings made here is, of course, light or ordinary, but this fact seems to be ignored. At any rate, 65s. on trucks can be obtained for them easily, and no questions asked. For heavy steel scrap there is no inquiry at present, although this is anticipated by dealers when the holidays are done with. The nominal price is 105s. on trucks, upon which a profit or commission of 2½ per cent. may be charged. Cast scrap is firmly held, and dealers are apparently satisfied with the business obtainable, although this cannot be very large. It may, however, improve considerably when the foundries begin again to buy pig iron. The price asked for an ordinary quality of broken castings is 102s. 6d. per ton delivered, and for good machinery castings 105s. to 107s. 6d. There is a special price for textile machinery castings, and especially for those from spinning machinery. Some dealers have obtained 115s. per ton for these latter, which are probably used for mixing in the place of Scotch pig iron, costing some 15s. per ton more. The position in wrought scrap is unchanged since I last wrote, unless it be that dealers are more cautious as to what they are doing. There is, at any rate, no open buying and selling at more than the official prices; and as nothing can be done at these prices the business appears to have come to a full stop. It is possible, of course, that some secret sales may be made, or some trade in such material as wrought iron piping, which is not technically heavy scrap, and can always be obtained at less money.

LATER.

A new Scrap Order has just been issued. In this the price for wrought scrap is fixed at £6 5s. per ton. This figure is not high enough, but I must leave the matter to be dealt with in my next report.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a very active demand for hematite pig iron. On local account steel makers are using up big tonnages of metal every week from the Barrow works and could take more. On general account consumers' requirements are full, and likely to remain so for some considerable time. The output of iron in Cumberland was last week very materially cut down owing to labour troubles, but these are now over and the furnaces are at work again. Prices are unchanged, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton, while special brands of iron are at 140s. per ton f.o.t. Warrants are idle; the stores represent only 450 tons.

Iron Ore.

The necessity for a full and adequate supply of iron is pressing. The strike of miners in Cumberland cut down the supply in that county and affected other places, but in North Lancashire there has been no cessation of work at the pits and smelters were able to carry on. It is hoped that at last a definite settlement has been arrived at. Many more men are wanted at the mines.

Steel.

The steel trade is very actively employed. This activity for the most part has relation to the production of semi-manufactured steel, such as billets, and good outputs have been maintained. With regard to finished steel, the demand is quiet. Rails now and again received attention on special account, but nothing is being done in ship plates. The steel foundries are fully employed. Prices are steady, with heavy rails at £10 17s. 6d. to £11; light rails, £14 to £14 10s.; heavy tram rails, £14; billets, £10 7s. 6d.; ship plates, £11 10s.; boiler plates, £12 10s. per ton.

Fuel.

There is a keen demand for steam coal, and prices are unchanged, with good average sorts at 25s. up to 27s. 6d. per ton for best qualities, delivered. Coke is in urgent demand at 33s. to 35s. 6d. per ton delivered for East Coast qualities, while Lancashire sorts are at 31s. per ton delivered.

SHEFFIELD.

(From our own Correspondent.)

The University's Glass-house.

RECENTLY I spent an interesting morning at the glass-house just completed for the Sheffield University, and noticing the official announcement on the front page of THE ENGINEER regarding facilities provided there for students from any part of the country, I am tempted to give some little idea of what has been done by the University's new department on Glass Technology where, for the first time in the history of glass-making, diplomas may be won by students. Dr. W. E. S. Turner, the head of the department, commenced operations a couple of years back, in conjunction with the movement inaugurated in London by Professor Jackson and others, with the Institute of Chemistry, to establish in this country the manufacture of chemical and optical glassware, and, to help matters forward by bringing together representatives of British glass firms, the Society of Glass Technology was formed with its headquarters at the University here. That Sheffield should take a prominent part in the movement was not surprising, for more than 50 per cent. of the glass industry is settled in the West Riding of Yorkshire, and it was a Barnsley firm, I believe, which, from Professor Jackson's formula, first essayed the manufacture of laboratory glass, of which the great engineering and steel works were very badly in need. At any rate, that honour belongs either to Barnsley or Perth, perhaps to both. In those days the University conducted experiments upon a very humble scale in a sort of garret. Now a fairly large red brick and stone building has been erected, and is rapidly being equipped with the very last word in glass factory plant.

A Lead to Manufacturers.

The glass-house proper is splendidly lighted and ventilated. Much of the plant is already installed. When everything is in its place it will contain three pot furnaces, each to hold a 2 cwt. crucible, and two "tankers." To the furnaces are attached pipes for gas and air blast, these being conveyed from the meter-house down below, where the gas meter (town's gas) has a capacity of 6000 cubic feet per hour. There is, of course, a pot-arch for heating up crucibles and an annealing furnace with a 20ft. lehr, but one of the most interesting features is a series of furnaces designed for melting on a small scale and working up by stages, so that note may be taken of the changes in the physical properties of the material experimented with. The first will be for melts of ½ lb., then of 1 lb., 5 lb., and 28 lb. in that order, and so to the 2 cwt. size. This will enable the working out of difficulties by stages. Pyrometers are installed, so that momentary indications of temperature or continuous records may be obtained. In every sense this is a model glass works, one that may be taken as a guide by those manufacturers who desire to reorganise and modernise their factories. Materials are brought up by electric lift from the storage room or by crane direct from the lorries, and all raw material, instead of being thrown wastefully about anywhere—which is the too usual custom—is kept in labelled bins. There are nine of these wooden erections with slide fronts and sloping spring lids and linings of cement and brick. They are on the ground floor, where also are places provided for a hydraulic grading apparatus, a big electric oven, weighing machine, sand sifter and other grading and mixing plant, beside a drying-room kept at a temperature of between 60–70 deg. Fah., a four-spindle electric grinding machine for polishing lenses, and a mechanical apparatus for slicing glass. In addition, of course, there are the laboratory and the "heads'" quarters, and it is anticipated that an early commencement will be made with electric glass melting. There will be presently a formal opening, but the department has already attracted quite a large number of students, who may be expected to revolutionise the glass industry still further, and to place it upon that scientific basis it should have occupied years ago.

Work for Wounded Soldiers.

What pleased me very much is the provision made in the building for the teaching of lamp-working. This is an easy, clean occupation, specially suitable for discharged soldiers unable to return to their former occupations, and a special effort is being made to attract them. The workers sit at long benches and are each provided with a brass gas burner and a blow-pipe, connected with the meters already referred to, With glass tubing as raw material, students are taught to make various kinds of scientific and surgical glass, including syringes, &c., whilst arrangements are to be made for giving instruction and practical demonstrations in the making of graduated glass and the grinding of stoppers for scientific glassware. Already from the tube quite excellent taps and stoppers are being blown, and ultimately it will be possible for skilled students to assist in the designing of new apparatus. Three courses are arranged, elementary, intermediate, and advanced, and it is considered that in about six months a learner would have an opportunity of earning permanent and fairly good wages—say, 50s. to £3 a week. This should appeal strongly to discharged soldiers, because in the general re-shuffling of labour after the war they might find that as semi-skilled or unskilled workers their places were lost in the ranks of industry, whereas this instruction would enable them to hold their own. This branch of the department is quite distinct from the work designed for the regular student on scientific lines. For him there is research work and all that it means for the real advance of the glass industry.

British Chemical Glass.

Whilst chatting with Dr. Turner, I took the opportunity of asking him if any definite conclusions had been arrived at, after two years' experience, as to the standing of British-made laboratory glass compared with the foreign pre-war supplies. He replied in the affirmative, and added that all the British-made chemical ware is now superior to similar glass which came into this country before the war. It is superior from the point of view of resistance to the attack of chemicals. Most of it, however, is not yet so good from the point of view of being able to withstand sudden changes of temperature, though this defect is in a large measure due to causes which can be alleviated. First of all only greater skill in gathering and blowing will improve the articles, and secondly the conditions for annealing will be presently more thoroughly understood. Already great strides have been made in those two respects; moreover, it has to be borne in mind in regard to these problems that for two years after Jena glass was introduced it was very unsatisfactory, and this, despite the experience which the German makers already possessed. It is not more than two years since British glass manufacturers began producing chemical ware, and the progress they have made calls for very considerable commendation. "Our glass," observed Dr. Turner, "simply wants tuning up."

Leaving Certificates.

An interesting situation has been created here this week on the question of leaving certificates. Upon an adjourned application coming before the Munitions Tribunal on Monday, Sir William Clegg, the chairman, said it was well known that a new Act had passed through Parliament and had received the Royal Assent. No one, however, knew when the measure would come into operation. That court had received no instructions. The matter had been considered that morning, and inasmuch as it appeared to be the clear intention of Parliament to abolish leaving certificates, he was advised that it would be best to grant all such applications irrespective of their merits. They therefore proposed to "anticipate the intentions of Parliament" and grant leaving certificates without going into details. The next day, at the sitting of the court, Sir William reverted to the subject. "I have instructed the clerk of the court," he said, "to write to the Ministry of Munitions in the matter, and I hope I shall have the answer by to-morrow. If so, I shall have the opportunity of making a statement on the subject; but at present the court must adhere to the practice introduced yesterday of granting certificates to applicants until we are instructed to the contrary." On Wednesday, however, Sir William announced in court that the clerk had received information from the Ministry of Munitions to the effect that such certificates must still be dealt with under the provisions of the Munitions of War Acts, 1915 and 1916, and the new Act must be ignored in this respect until such time as the Minister of Munitions makes an Order abolishing the necessity for such certificates, which, it is expected, will be done in the course of the next four or five weeks. "The old practice will therefore be revived," added the chairman, "and each case determined upon its merits. I am sorry if any inconvenience has been caused to any persons owing to my not having received proper instructions on the matter."

Tribunal's Value Criticised.

Another curious incident has occurred regarding the Munitions Tribunal since my previous letter. It may

be recalled that a fortnight ago I mentioned that, commenting on a reduction in the number of cases brought before the court, Sir William observed: "I am not prepared to say what the cause of the reduction is, whether firms now are not enforcing the regulations as rigorously as they used to do, or whether the men are conforming more to the regulations." In my letter I ventured to suggest that the cause must be looked for in the former circumstance. This view was fully borne out a few days later by Mr. C. E. Siddall, the managing director of the Sheffield Forge and Rolling Mills, Limited, who, addressing a meeting of shareholders, said the company took very few cases before the Munitions Tribunal, for two reasons. In the first place it did not pay, for if men were fined they would get the money back out of the company, plus extra for being taken to the court. Secondly, if the company could not manage its own men nobody else could. "Taking the men to court," added Mr. Siddall, "shames them, and I feel that that is not the proper way to deal with labour unrest. The best thing is to have the offenders up in the office, give them a good talking to, and a 'punching' if they require it, and a pocket-knife to go out with. They are perfectly satisfied, and the management hears no more about it."

Round the Works.

At the same company's meeting an instance of Sheffield works' development was revealed. The chairman spoke of the many extensions made during the past few years, and said they had been recently engaged in pulling down a considerable amount of property and erecting on the site a modern mill with up-to-date machinery. That work would be completed in a few months. Then at Templeborough, on the Sheffield-Rotherham border, a rolling mills, which will be probably the first of its kind in this country, is rapidly nearing completion. It is owned, as I think I have mentioned before, by a combination of four or five companies. Practically the only means of extending works here now is by pulling down old cottage property, and where this cannot be done developments have to be carried to outside districts. Such cases are occurring at the present moment, much to the loss of Sheffield's rateable value. There is a great deal of activity, I learn, in the manufacture of agricultural implements like reapers, scythes, harrow discs, and other machinery parts. To a large extent these are being made on account of home orders placed by some of the large agricultural implement firms, who realise that after the war the industry for which they cater will be one of the first to recover itself; but urgent demands are also coming from the Colonies, particularly Australia, though the difficulties of securing export licences are daily increasing. Many orders are filled, however, on overseas account, the latest including large quantities of steel for Osaka, Shanghai, Yokohama, Lyttelton, Melbourne, Montreal, and Toronto; saws for Singapore and Santander; tools for Batavia, Bombay, Wellington, Dunedin, Buenos Aires, Mossul Bay, and Punta Arenas; sheep shears for Monte Video, Buenos Aires, and Bahia Blanca; hardware for Calcutta; files for Rangoon, Singapore, Madras, and Calcutta; and cutlery for Bangkok and Montreal. Russia is taking large consignments of high speed steel on Government account, but private transactions are seldom entertained in the present state of uncertainty.

Iron, Steel, and Coal.

The topic of interest in the local iron market this week has been the withdrawal by the Ministry of Munitions of the Order made in March last drastically reducing the maximum price of heavy wrought iron scrap to a figure at which merchants found it practically impossible to do business. The new regulations will be found in another column of THE ENGINEER. Merchants generally appear to be satisfied with the change, which seems to have been the result of continued protest against the too low maximum of £5 5s. for heavy wrought stuff which, prior to March last, fetched as much as £7. It is now raised to £6 5s.—the same as the level for plates, which has not been changed—plus an allowance in consideration of handling scrap, for which a certain amount of carriage to buyers' works is involved. Here, however, merchants feel that the Order might have been made more definite, as present conditions may favour some merchants as against others. But they are glad of the concession and are willing to give a fair trial to the working of the new regulations. A new furnace is to be lighted up at Renishaw, I hear, but it will probably be put on to basic, as so many other Derbyshire furnaces have been. In such cases makers are indemnified against possible loss by the conversion of the furnaces from foundry and forge to basic, though, as a matter of fact, they stand rather to gain by the higher values obtained. Foundry and forge, and consequently bar iron, are in short supply. Hematite supplies are coming fairly well to hand. Most of the Derbyshire basic iron goes to Staffordshire, South Wales, and Scotland. The steel position is about maintained as to supplies, and values are very firm. Another couple of acid steel furnaces have come into operation at Templeborough—fifty tonners. As to the coal market, arrangements are now about completed for the substitution of house coal contracts where formerly these were being filled from districts now prohibited under the Controller's Order, but exemption has been secured for all manufacturing fuel for this district. Local demand is heavy and increasing, but many firms are managing to put a fair amount on the ground. Export trade is unchanged. Slacks are steady, and house coals very firm. Best South Yorkshire steam hards are quoted at 17s. 6d. to 18s.; Derbyshire, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 16s. 9d.; best hard slacks, 12s. 3d. to 12s. 6d.; seconds, 11s. 9d. to 12s. 3d.; soft nutty, 12s. to 12s. 3d.; peas, 10s. to 10s. 6d.; and small slacks, 6s. to 6s. 6d. In house sorts branch is quoted at 21s. to 21s. 6d., and best Silkstone, 18s. to 18s. 6d., all per ton at pit. Coke is very firm on maximum rates.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE Cleveland pig iron trade position continues very firm. This week there have been indications of a revival in business, following upon the end of the August holiday period. The home allocations for September are now coming out, and merchants report that they are heavier than those for the month now ending, particularly in the case of the foundries in the North of England. The revival of activity is reflected in the quickened demand for iron, and already substantial parcels for September delivery have been fixed. The supply of foundry iron is fully adequate to meet all requirements, and there is no difficulty in placing orders. There is no interest in the forward position as regards the foundry qualities, but a certain amount of business is being put through for forge iron over a few months. The export trade is comparatively quiet. A few allotments for the July period have now come to hand on Italian account, and French supplies are being arranged through official channels. But so far as merchant business is concerned, the quantities as yet released are small. No. 3 Cleveland pig iron, No. 4 foundry, and No. 4 forge are all firm at 92s. 6d., with a premium of 4s. for No. 1. Export quotations are: No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; No. 4 forge, 100s. 6d.

Hematite Pig Iron.

A very busy state of affairs continues in the hematite pig iron trade of this district, and the only difficulty is that smelters of iron are not able to cope with the amount of business that is on offer. The needs of makers of munitions, not only on local but on general account, are very heavy, and will, from all appearances, be heavier in the immediate future. Makers are therefore putting forth renewed efforts to meet these requirements—no easy matter when the different restrictions have to be taken into consideration. New forward business is stagnant. Against old contracts everything possible is being done to facilitate shipment of iron already licensed to our Allies, but it is fully recognised that future allocations cannot be heavy. The export price to the Allies—no hematite is going to neutrals—is understood to have been fixed at 141s., plus the amount of excess freight above the parity agreed on for the various ports. Sellers are waiting on this understanding, though it has apparently not yet received formal Government sanction. The home maximum price is unchanged at 122s. 6d.

Iron-making Materials.

Foreign ore deliveries are still somewhat irregular, but in the circumstances are fairly well maintained. The efforts to increase the supply of home ore are making satisfactory progress. Coke is strong, with good medium furnace kinds at about 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

Now that work has been resumed in all its intensity in the Cleveland and Durham districts, after a well-deserved week's holiday, steel makers report not only excellent business, but every prospect of a continuance of this state of affairs, and so far as can be foreseen at high and steady prices. Although in certain quarters some absolutely unavoidable delay took place in the completion of the necessary repair work carried through during the holiday, the way in which labour in the steel works was resumed on Monday morning was a great credit to the patriotism of those employed there. A very busy time lies in front of all engaged in the production of steel, for there is no falling off in Government orders for all classes of material. Indeed, rather is there a decided increase in the demand for material required for the prosecution of the war. So speedily is the output absorbed on Government account that ordinary and export business has faded away practically to a vanishing point, with little chance of a revival, although, under special circumstances, some small lots are being shipped to France and Italy. There is plenty of inquiry from oversea sources, but the Government is holding up applications for permits in a somewhat drastic fashion. Similar conditions prevail in the manufactured iron trade. The demand increases from day to day, and order books are well filled, every establishment being actively employed. Prices of all descriptions are exceedingly firm. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ¾in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 3/16in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12; all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

A brisk demand continues for all kinds of steel scrap, but the supply falls short of requirements. Steel bars and billet crops are the main supply of the new steel scrap obtainable locally. Of course the steel works also consume the crops from their own bars and billets, in many cases putting back into the furnace material which merchants would gladly purchase at a good figure for customers who have facilities for rolling them down. But the steel works are kept so short in the supplies of other raw material that they are forced to forego the profit which could be obtained by selling the larger crops. In foundry scrap only a small business is reported.

The Coal Trade.

Conditions in the coal trade in the North of England, which have been unsatisfactory for the past few weeks, show little sign of improvement. The markets remain very quiet, the only inquiries circulating being for some cargoes for Norway and Denmark. In all other directions there is lack of tone, owing to the restriction of speculation, and the long continued uncertainty, almost amounting to insecurity. It is felt that the existing regulations relating to distribution cannot last, and the only question is whether the alteration will be for better or worse. A system which produces a slump in one locality and a famine in another not far distant, can scarcely be described as a success. There are certain manufacturing, industrial, and densely populated districts which can account for their fuel output, while there are others with large surplusse available for places where there is no coal, or where it is not worked and for shipment. South of the Trent, which divides England pretty equally, and in the Eastern Counties, coal is commercially non-existent, and the problem is for the North to supply the South and the ports. This problem should not be an insuperable one in the hands of an experienced traffic manager, having control of the railways, canals, and shipping. In the Northumberland section there is only a moderate demand for best steams, while for smalls the supply far exceeds requirements, and stocks are accumulating. For smithies, peas and nuts there is a brisk home demand, leaving little surplus for distribution. The coking coal output is well taken up for the home market, but the export trade is very quiet. Foundry coke is in active demand, both for home and export. The Durham situation shows a slight improvement on the week. Best gas and specials are in fair request. Secondary gas is only moderately placed, but coking fuels are in good demand, both for export and for home market purposes. There is also a fairly heavy demand for unscreened steams, nuts and smithies for the home manufacturing market. The bunker market remains very quiet, the trade passing being negligible. Quotations are as follows:—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 28s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SCOTLAND.

(From our own Correspondent.)

War Bonuses and Wages.

IT is understood that the North British Railway Company directors have agreed to increase by 10 per cent. the salaries of all members of the staff who are in receipt of not more than £500, and who are not already receiving the war bonus of 15s. per week. This will affect officials with salaries from a little over £200.

New Electric Power Station at Glasgow.

The Glasgow Corporation has in course of erection at Dalmarnock a new electrical power station. Proceedings have been greatly hindered by the war, but it is intended shortly to fix contracts for the superstructure of the boiler and turbine houses. The total area covered by the station is fully 13 acres, and there is to be provided a coal storage capacity of 75,000 tons. The ultimate capacity of the station will be from 150,000 to 200,000 kilowatts, and the first installation will consist of two 15,000 kilowatt sets.

Pig Iron.

There is marked activity in the pig iron trade, especially among producers of hematite. The other qualities are also in great demand, but are difficult to secure, particularly No. 1 foundry. Shipment continues dull, as there is practically nothing available for export. Prices are firm.

Quotations.

Monkland and Carnbroe, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

There is no fresh feature to report with regard to the steel and iron trades. Everything is now so much under control or subject to licence, that there is little variation in the run of business from one week to another. The requirements of all classes of materials are steadily growing, and producers are hard put to it to fulfil their obligations, despite additions to works and plants. Steel makers have numerous inquiries from consumers, both at home and abroad, but, after military and naval needs are satisfied, the supplies for ordinary distribution are only a drop in the bucket. Black steel sheets are still scarce, but it is expected that an increase in outputs will be effected shortly. The output of malleable iron has fallen considerably below the average. Every available mill is being put on to the production of steel, and, consequently, iron users have to be content to a large extent with discarded material. "Crown" iron bars, however, are still firm at £15 15s. to £16 per ton, f.o.b. Glasgow. General engineering work of all descriptions is plentiful, while structural engineers, particularly, have no lack of profitable employment.

Coal.

Conditions in the Scotch coal trade continue dull. Business is carried on under increasing difficulties, and until there is an expansion in the export turnover there is not likely to be an improvement in business generally. In the West of Scotland district the industrial demand is fairly well maintained, and collieries are managing to keep things moving, but in Fifeshire and the Lothians the local requirements are quickly satisfied, and with business from other quarters in meagre quantities irregular employment is prevalent The aggregate shipments from Scottish ports during the past week amounted to 191,415 tons, compared with 177,692 in the preceding week, and 214,546 tons in the corresponding week of last year.

Fll coal is quoted f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s.; first-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 30s.; first-class steams, 28s.; third-class steams, 24s.; best steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Transport Reorganisation.

Coal owners have this week received from the Coal and Coke Supplies Committee certificates instructing them to whom they are to supply coals in substitution of contracts which have been cancelled in order to save long railway haulage. This has been done in connection with the Coal Transport Reorganisation Scheme which comes into force on September 8th. In almost all cases, so far as can be ascertained, collieries are called upon to supply for home consumption a greater quantity than they have hitherto provided, so that these increased quantities will be taken out of what was previously exported. The instructions which have been received by the collieries have been very freely discussed, and in many cases very strongly criticised, because it is expected that the fulfilment of the orders which coalowners are called upon to carry out will be followed by many serious complaints from the consumers. Coals which are regarded as altogether unsuitable for home consumption, particularly for household purposes, are ordered to be supplied, including steam coals and dry coals, which, it is feared, will not adequately take the place of coals which works, &c., have been accustomed to use. One ground for complaint on the part of some coalowners is that the committee has unnecessarily interfered with existing contracts. For instance, it is pointed out that one company which has been sending monthly a certain quantity to a Yorkshire town has been instructed to suspend delivery upon this contract, and has been ordered to supply a larger monthly quantity to a neighbouring Yorkshire town. This, it is stated, is not an isolated case, and is unnecessarily disturbing to business arrangements.

House Coal Distribution.

The scheme prepared by the District Coal and Coke Supplies Committee for South Wales and Monmouthshire, to deal with the question of supplies during the winter months to merchants, has now been issued. It provides, in the case of those merchants who have previously purchased from colliery companies in South Wales, that the collieries shall supply them with the same quantities during September, October, November, and December next as they supplied during the corresponding months of 1915. This continues the course which has previously been adopted, as each company will know to whom, and what quantity it will have to supply. Colliery companies, however, have been advised that they will be entitled to deduct from a merchant *pro rata* in each of the above months any quantity which they supplied to such merchant in excess of the total quantity which he was entitled to from April to August, 1917, inclusive, under the terms of the scheme issued by the Committee on March 30th last. This condition is made in view of the fact that many merchants obtained an increased summer supply to enable householders to stock for the coming winter. With regard to merchants who will be unable to obtain coal after the 8th September from areas from which supplies into South Wales will be prohibited, the Committee is allocating to each merchant coal in substitution from collieries in Monmouthshire and South Wales.

Current Business.

Operations on the coal market this week have been on a very small scale, but shipments are proceeding fairly briskly. It is expected that collieries will be able to maintain regular work at the pits to the end of this week, but it is doubtful whether the conditions will be sufficiently favourable to enable them to continue to do so next week. The small coal question is an ever-present trouble. Supplies are accumulating to such an extent that they are a menace to regular work at the pits. This results in colliery companies becoming short of wagons. Since I wrote a week ago the Coal Controller has sanctioned a revision of the schedule of prices in respect of No. 2 Rhondda through and small coals. No. 2 through coals are now divided into two classes, that for best being fixed at 23s. 6d., and second qualities at 22s. No. 2 Rhondda smalls were formerly 20s., but these also are now in two categories, with best at 19s. and second descriptions at 17s. It is also understood that bunker and cargo smalls are to be re-classified, and are to be divided into no less than eight classes, with best at 21s. 6d., and the lowest class at 18s., so that there will be a difference of 6d. between each class. The patent fuel market is very steady at 30s. to 32s. 6d. Very little fresh business is passing, but makers are well engaged on contracts. The supply of pitwood is not quite so good, with the result that prices are rather firmer, at 59s. to 61s.

Later.

The coal market is unchanged in any department, and trade is quiet. Very few orders are about. Schedule prices are in operation all round in respect of coals and coke. Patent fuel and pitwood are very steady.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 22s. 6d.; unwashed duff, 18s.; second duff, 16s.; third duff, 14s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, best, 23s. 6d.; through, seconds, 22s.; smalls, best, 19s.; smalls, seconds, 17s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. to 32s. 6d.; coke, 47s. 6d.; pitwood, ex ship, 59s. to 61s.

Newport.

The tone of the market has lost some of its buoyancy, there not being the pressure for supplies that was so noticeable in the early part of this month. Stems are easier. Small coals are the weakest section of the market. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s. to 32s. 6d.; pitwood, ex ship, 59s. to 61s.

Swansea.

There has been no very conspicuous movement in the anthracite market. Tonnage arrivals have been fairly satisfactory, and the demand for large description and machine made qualities has been well maintained, but rubbly culm and duff have met with a very slow inquiry. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine-made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 8s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, through, 23s. 6d.; smalls, 17s. Bituminous coal: No. 3 Rhondda large, 27s.; smalls, 24s. Patent fuel, 30s.

Tin-plates.

Brisk conditions prevail in the tin-plate trade, and the market is steady at the maximum prices which have been fixed by the Minister of Munitions. The maximum prices for coke tin-plates apply to all sales as from July 19th last per basis box, net f.o.b. makers' works or nearest station. The price for I.C. 20 × 14, of 112 sheets, 108 lb., is 30s., and for terne plates 28s. per box. The prices are fixed upon the basis of the selling price of block tin at £240 per ton. Quotations: Block tin, £241 5s. per ton cash; £239 15s. per ton three months; copper, £120 per ton cash; £119 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

THE DEVELOPMENT OF GERMAN WATERWAYS.

With reference to the projected development of German waterways the *Board of Trade Journal* gives some particulars taken from the issue of *Handel and Gewerbe* of 28th July. According to that publication the Imperial authorities intend to make a contribution to the cost of the plans for such development. It states, too, that there appears in a third supplement to the Imperial Budget for 1917, which has been passed by the Bundesrat and laid before the Reichstag by the Imperial Chancellor, the non-recurring item of 1,200,000 marks as a contribution to the working out of plans for the development of the German system of waterways. The Imperial authorities will contribute to the cost of the working out of plans the execution of which would be to the economic advantage of Germany as a whole. Such plans comprise, in the first place, the connection of the Rhine with the Danube by the Main, the Neckar, or Lake Constance; and, further, the provision of waterway connections in the watershed of the Weser, the Elbe, and the Oder.

The preliminary allocation of the 1,200,000 marks is as follows:—For plans for—(*a*) A waterway for large vessels from Aschaffenburg to the frontier of the Empire below Passau, 700,000 marks. (*b*) A waterway for large vessels from the Rhine to the Danube, by way of the Neckar, including rendering the Danube navigable from Ratisbon to Ulm, and connection of the Upper Rhine with the Danube, *viâ* Lake Constance, 100,000 marks. (*c*) Other schemes, 400,000 marks. The detailed allocation of these amounts, which in no case are to constitute more than two-fifths of the outlay necessitated, is to be arranged by the Imperial authorities with the authorities of the particular States in question. The Imperial participation in the outlay on plans is solely to ensure the testing of the feasibility and value of the separate schemes from the point of view of Imperial interests; it in no way prejudices any future decision on the part of the Imperial authorities as to whether, and to what extent, they should undertake part of the costs of execution of one or other of the schemes.

THE INDUSTRIAL LEAGUE.

A misunderstanding existing as to the functions of the Industrial League, we are asked to state that the gentlemen whose names we mentioned in our issue of July 27th were present as guests, and not in any official capacity that could clash in any sense with their duties to other bodies with which they may be associated. The dinner on July 20th was just as informal as preceding dinners, and it was not till after it that the league took the title by which it is to be known in future, and decided to increase its field of endeavour. Hence it cannot be said of anyone who was present—and we may, since we are asked to do so, particularly mention Mr. P. V. Vernon—that he was in any way showing adherence to an association whose work might conceivably clash with that of other federations.

CATALOGUES.

Boving and Co., Limited, 56, Kingsway, London, W.C. 2.—Illustrated catalogue of "Boving"—Victoria—turbo pumps.

Broom and Wade, Limited, High Wycombe, has sent us blotting slips, on which are set forth the claims to attention of the Hyatt type of roller bearings.

The Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.—Record No. 85, illustrated descriptive pamphlet, giving particulars of the firm's internal combustion locomotives.

The Spray Engineering Company, 93, Federal-street, Boston, Maine, U.S.A.—Illustrated pamphlet describing this firm's Spraco paint gun and pneumatic painting equipment.

The British Thomson-Houston Company, Limited.—Descriptive list, No. 4160 A. Illustrated pamphlet describing the firm's "Ironclad Draw-out Oil-break Switchgear," type O. Forms J1 and J2.

The Judson Jackson Company, Limited, 50, Marsham-street, Westminster, S.W. 1.—This firm has sent to us a nicely got up souvenir, illustrating some of its specialities, and giving various views of its works, offices, &c.

The British Westinghouse Electric Manufacturing Co., Limited, Trafford Park, Manchester.—Instruction Book 5010/1, "British Westinghouse Motors and Generators in Industrial Service—Installation, Operation, Care and Repair."

J. H. Williams and Co., Brooklyn, New York.—Catalogue in Russian, illustrating and describing drop forged tools, &c., such as spanners and wrenches of various types, tool holders, lathe dogs, gauges, cramps, shackles, eye bolts, crane hooks, butterfly nuts, &c.

The British Steel Piling Co., of Dock House, Billiter-street, London, E.C. 3, has sent us a neat waistcoat pocket edition of its large catalogue. The little book, small though it is, contains a large amount of useful information regarding the firm's system of sheet piling.

Hollings and Guest, Limited, Thimble Mill-lane, Birmingham.—Illustrated descriptive catalogue dealing with pumps of various kinds, including hand, belt driven, geared, motor driven, vertical and horizontal pumps for all pressures and capacities; and illustrated descriptive catalogue dealing with hydraulic presses and screw presses, hydraulic tire-stretching machines, tire blocks, and special machines for tire makers.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W.

ORDERS

For the week, by Lieut.-Col. C. B. Clay, V.D., Commanding.

Extract from London Gazette, August 23rd.—County of London Volunteer Engineers, Lt.-Col. C. B. Clay (Lt.-Col., late Lancs. Vol. Artillery) to be temp. Major (May 15th); E. C. R. Monson (late Major, City of London Regt.) to be temp. Major (second in command) (May 15th). To be temp. Captains:—W. D. Bentley, E. G. Fleming, W. Hynam (late Captain, Reserve of Officers), P. M. Yearsley (late Captain, 16th Midx. Vol. Rif.) to be temp. Captain and Adjutant (May 15th). To be temp. Lieuts.:—W. J. A. Watkins, A. J. N. Gerard (May 15th). To be temp. Second-Lieuts.:—P. Bowden, C. E. Campbell. A. Champion to be temp. Hon. Lieut. and Qrmr. (May 15th).

Officer for the Week.—Lieut. W. J. A. Watkins.

Next for Duty.—Second-Lieut. P. Bowden.

Monday, September 3rd.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class, 6.30. Recruits' Drill, 6.30.

Tuesday, September 4th.—Physical Drill and Bayonet Fighting, 7.30.

Wednesday, September 5th.—Drill and Elementary Bridge Construction for No. 1 Company, Left Half Company.

Thursday, September 6th.—Drill and Elementary Bridge Construction for No. 2 Company, Left Half Company. Signalling Class, 5.30. Ambulance Class, 6.30.

Friday, September 7th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Musketry.—All N.C.Os. and men who have signed the "A" and "B" agreements are required to attend during this month to reclassify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be had at headquarters, and every enrolled man must obtain one without delay, at the same time all old red armlets (now obsolete) must be returned.

Note.—Unless otherwise indicated, all drills will take place at headquarters.

By order,
Macleod Yearsley,
Captain and Adjutant.

September 1st, 1917.

EDUCATIONAL INTELLIGENCE.

The examination for the Goldsmid Engineering Entrance Scholarship at University College, London, value £30 a year for three years, will take place in September. Candidates should apply to the secretary of University College, London, for full particulars as soon as possible, and not later than September 11th.

The Martell Scholarship has been awarded by the Council of the Institution of Naval Architects to Mr. H. C. Carey, of Chatham Dockyard. The scholarship is of the value of £100 per annum, and, subject to the regulations governing the same, is tenable for three years. The Earl of Durham Prize has been awarded to the second candidate in order of merit, Mr. H. D. Leggett, of Portsmouth Dockyard.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Central Press asks us to state that owing to the Government having taken over its old offices at Palace Chambers for the Food Controller, the address to which all communications should be sent until further notice will be: The Central Press, 45, Parliament-street, Westminster, S.W. 1. Telegraphic Adress: "Cenprestra, Parl: London. The telephone number has not been altered, viz.: Victoria 3670.

Charity Sports at Chelmsford.—Three large works in Chelmsford, viz., those of Crompton and Co., Limited, the Hoffmann Manufacturing Company, Limited, and Marconi's Wireless Works Company, Limited, carried out a sports meeting, arranged amongst the employees, on the ground kindly lent by the Crompton Club, on Saturday, August 25th. There was a large attendance of the public. The meeting had for its objects—to help the Essex Regiment Comforts Fund, the Essex Regiment Prisoners of War Fund, and St. Dunstan's Hostel for Blinded Soldiers and Sailors. Most of the events were restricted to employees of the works, but there were a few open events which attracted large entries, many of the men being in khaki. In the reserved enclosure were present, as guests, many wounded soldiers from the local hospitals. The prize money was kindly provided by the directors of the three companies. Crompton's easily secured first place in the matter of prizes, winning nine firsts, five seconds, and five thirds; Marconi's being second with five firsts, five seconds, and three thirds; Hoffmann's securing two firsts, five seconds, and five thirds. The prizes were distributed by Mrs. Britten, wife of Mr. Thomas Britten, director of Crompton and Co., Limited. In the evening an *al fresco* concert took place on the bowling green.

THE PRICES OF STEEL AND WROUGHT IRON SCRAP.

The Ministry of Munitions on the 28th inst. issued two Orders, one dealing with the prices of steel scrap, and the other with those of wrought iron scrap. The first Order cancels the Orders dated the 31st October, 1916, and the 1st January, 1917, respectively, in so far only as the same relates to steel scrap, and refers to steel scrap of all classes and descriptions. In the present Order notice is given that, as from the 28th inst., the Minister of Munition withdraws the two notices of the 1st January, 1917, adding to and modifying the general permit of 1st November, 1916, in so far as they relate to steel scrap, and that he cancels the price fixed in the schedule to that general permit for special handy heavy steel melting scrap suitable for crucible use, and special short extra heavy steel turnings, the following maximum prices being substituted :—

Maximum Prices for Steel Scrap.

1. (*a*) Heavy steel melting scrap, £5 5s. per ton ; (*b*) steel turnings and borings, £3 10s. per ton ; (*c*) steel turnings and borings mixed with wrought iron or other material, £2 10s. per ton ; (*d*) all other classes of steel scrap, heavy or light, whether or not mixed with wrought iron or other material, £5 5s. per ton.

2. All these prices are free on rail or free in barge at the nearest convenient siding or wharf to the place where the scrap lies at the time of sale ; the carriage at actual cost, or at a fair average rate agreed between the seller and buyer may be charged to the buyer up to a maximum of 10s. per ton.

3. To these prices a sum not exceeding 2½ per cent. on such prices may be added in the case of sales by recognised scrap merchants.

Special permits to purchase steel scrap sold with guaranteed analysis may be granted on application, but in no case will permits be granted for any such purchase at prices exceeding the following :—Heavy steel melting scrap containing not over .04 per cent. phosphorus and sulphur, £6 5s. per ton ; heavy steel melting scrap containing not over .05 per cent. phosphorus and sulphur, £6 per ton.

Wrought Iron Scrap.

The second Order, dealing with wrought iron scrap, sets out that, with reference to the Order made by the Minister of Munitions on the 22nd March, 1917, regarding this material, and to the general permit issued by the Minister of Munitions on the 1st November, 1916, under the Orders of the 7th July and 31st October, 1916, and to the notice issued by the Minister of Munitions on the 22nd March, 1917, extending the said general permit to certain classes of wrought iron scrap, the Minister of Munitions gives notice that, as from the 28th inst., he withdraws the notice of the 22nd March, 1917, and that the said general permit shall henceforth take effect as if the war material referred to in the Order of the 22nd March, 1917, namely, wrought iron scrap, were included in the Order of the 7th July, 1916, and the following material and prices were specified in the schedule to the said general permit, "provided always that Condition 2 of the said general permit shall not apply to any sale or purchase of the war material last mentioned under a contract in writing entered into prior to the date of this notice, at a price not contravening that permitted up to such date." The maximum prices above referred to are for

1. Wrought iron scrap of the classes defined or mentioned in (*a*), (*b*) and (*c*) below, £6 5s. per ton. (*a*) Wrought iron plates, boiler plates and sectional material not less than ¾in. thick, each piece separate, reasonably clear of rivets, without any flanged end plates or circular angles and plates, all suitable for shearing, cable scrap and chain scrap not less than ¾in. diameter. (*b*) Heavy wrought iron scrap not less than ¾in. thick, including horseshoes, rivet and bolt scrap, scrap from the manufacture of rivets and bolts, and chain scrap not less than ¾in. diameter. (*c*) Wrought iron scrap under ¾in. thick, including country wrought iron scrap and all wrought iron scrap not included in any of the classes defined in 1, 2 or 3 of the Order.

2. Wrought iron scrap mixed with steel or other material, £5 5s. per ton.

3. Wrought iron turnings and borings mixed with steel or other materials, £2 10s. per ton.

4. The prices of wrought iron scrap and mixed scrap may be arranged between buyer and seller, but may not exceed in the cases of 1, (*a*), (*b*) and (*c*), £6 5s. per ton, and in the case of 2, £5 5s. per ton, and in the case of 3, £2 10s. per ton.

5. The above prices do not apply to heavy forging scrap, nor to scrap from the following brands of Yorkshire iron :—Lowmoor, Farnley, Monkbridge, Taylor Brothers, Bowling, and Cooper Brothers.

6. The above prices are free on rail, or free in barge, at the nearest convenient siding or wharf, to the place where the scrap lies at the time of sale.

7. The above maximum prices of wrought iron scrap, if selected, loaded in and delivered from yards used as scrap yards at the date of the Order by recognised scrap merchants, may be increased : (*a*) Where carriage to buyer's works does not exceed 3s. per ton, by 10s. per ton ; (*b*) where carriage to buyer's works exceeds 3s. per ton, by 7s. 6d. per ton ; (*c*) if sheared and cut up ready for piling, by 15s. per ton.

8. To the above-mentioned prices for wrought iron scrap a sum not exceeding 2½ per cent. on such prices may be added in the case of sales by recognised scrap merchants.

All communications with reference to the above Orders should be addressed to the Director of Steel Production, Room 381, Ministry of Munitions of War, Whitehall-place, London, S.W. 1.

The world's production of copper in 1916 was 1,396,600 tons, as compared with 1,061,300 tons in 1915, an increase of 335,600 tons. The 1914 output was 923,909 tons, and that of 1913 was 1,066,000 tons. Of the 1916 total 880,880 tons are credited to the United States, the output of which in 1913 was 556,000 tons. The Geological Survey of that country has estimated the production of smelter copper for 1916 at 1,927,850,848 lb., or 860,647 gross tons. Next in importance ranks Japan with 90,000 tons in 1916, followed by Chili with 66,500 tons, and Mexico with 55,000 tons.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

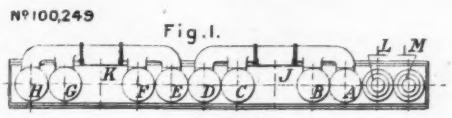
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

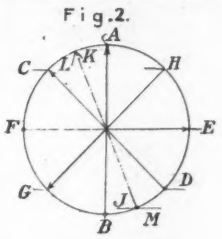
The date first given is the date of application ; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

100,249 (4495 of 1916). March 27th, 1916.—Diesel Engines, Société Anonyme des Etablissements Delaunay Belleville, Rue de l'Ermitage, Saint Denis (Seine), France.

This invention is for a two-stroke cycle Diesel engine, having eight working cylinders, two scavenging air compressors and two blast air compressors. The grouping of the cylinders is such that four of them are adjacent to a scavenging compressor, and the other four are disposed at a distance from the compressor, the distance being approximately the width of a cylinder. In Fig. 1 the engine cylinders are divided into two groups, the first group comprising the cylinders A B C D, and the second comprising the cylinders E F G H. Each of these groups is served by a scavenging air compressor J and K placed in the middle of the group and feeding two engine cylinders on each side. The cranks of the engine cylinders are situated in planes forming

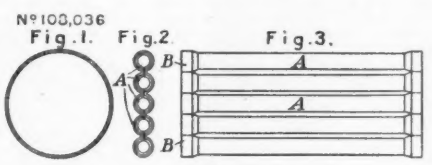


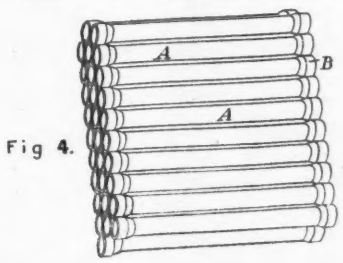


angles of 45 deg. with one another, and each engine crank belonging to a cylinder designated by an even index number is opposite to the immediately preceding odd crank. In this way is constituted a total of four groups, each consisting of two cylinders, and each operating as a two-crank two-stroke cycle motor with a respective displacement of setting of 45 deg. to the next group. The regularity of the torque is therefore as great as possible. Judicious setting of the compressor cranks, it is claimed by the inventors, enables an almost perfect balance of the inertia forces to be obtained, thus eliminating all or approximately all vibration of the motor on its base plate. The two scavenging air compressors should be set so that their crank pins are at J K, and the cranks of the blast air compressors should be placed at L M, as shown in Fig. 2.—*July 26th*, 1917.

108,036 (10,500 of 1916). July 26th, 1916.—Radiators, Josiah Edwards, 81, Francis-road, Erdington, Birmingham, and others.

This invention is for the manufacture of radiators built up of a series of tubular members of large diameter, which are pressed so as to produce from one large tube a section having the appearance of a number of tubes. The arrangement is shown in Figs. 1–4, Fig. 1 being the one large tube which is pressed to a more or less elliptical shape, being finally drawn or pressed so as to have the appearance of small tubes placed side by side, which is effected by forming opposing depressions in opposite sides of the tube leaving semi-circular internal grooves within the tube, which, when brought together, have the appearance of completely

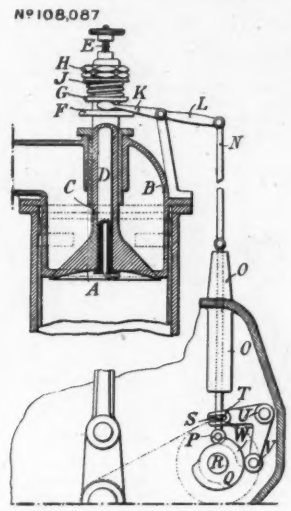




circular small tubes A. In practice the radiators are built by disposing these tubes or series of connected tubes in vertical planes, as seen in Fig. 4, so as to permit the water to circulate between them. To separate the tubes over the greater part of their length their extremities are formed with a slightly greater diameter, as B, than the main length, so that when two of the walls of tubes are placed side by side their ends contact together whilst leaving a passageway for the circulating cooling water between the main lengths, whilst between these composite tubes horizontal openings are provided permitting horizontal water circulation, which is not possible with a radiator built from flat tubes extending from top to bottom of the radiator.—*July 26th*, 1917.

108,087 (15,914 of 1916). November 7th, 1916.—Combination Tappet Valve and Ignition Plug, John Mathieson Brewster, Crowmallie, Pitcaple, Aberdeen.

The large tappet valve A is arranged axially to the cylinder in a combustion head B which forms a large inlet chamber vertically upwards through which its stem C extends. The stem C is hollow, and within it is arranged an elongated sparking plug D provided with the usual terminal E. There is a shoulder F on the stem, and a loose collar G, and between the loose collar and lock nuts H on the stem end is arranged a buffet spring J in compression. A jaw K on one end of a tappet lever L, mounted on a bracket on the cylinder, engages between the collar G and the shoulder F. To the other ends of this lever L is pivotally connected the upper end of an articulated tappet rod N, the lower end of which is guided in a tappet guide O. On the bottom of the rod N is a roller P which is engaged by a cam Q on the usual lay shaft R. A pin S near the lower end of the tappet rod is engaged by a jaw T on one arm of a bell-crank U pivoted in

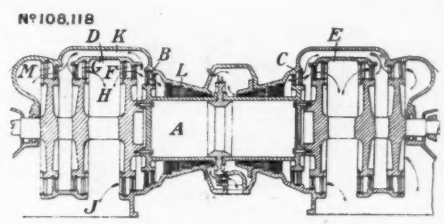


the crank case, and the other arm of which bears a roller V engaging a second cam W on the shaft R. The valve is both opened and closed positively, the function of the buffer spring being on the one hand to ensure final closure of the valve, and on the other to prevent damage on account of expansion or faulty adjustment.—*July 26th*, 1917.

TURBINE MACHINERY.

108,118 (796 of 1917). January 16th, 1917.—Steam Turbine, Herbert Thacker Herr, 218, South Dallas-avenue, Pittsburg, Penn,, U.S.A.

This invention is for a turbine of the axial flow type having a section through which motive fluid flows in one direction only, and a divided flow low-pressure section, divided into at least three sub-sections working in parallel. Means are provided for delivering the steam discharged from the first-mentioned section to the sub-section, so arranged that the fluid flows through the adjacent sub-sections in opposite directions. In the sectional drawing A is the turbine rotor of the Parsons, reaction or other double-flow type. B and C represent low-pressure sections, from which the steam is exhausted into the sections D E, which

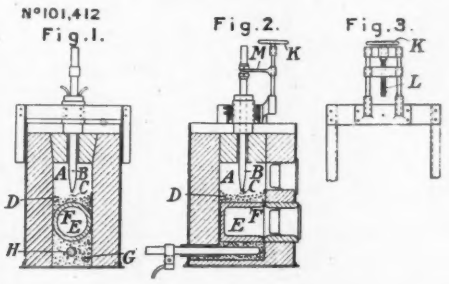


are duplicates. By reference to the low-pressure section D it will be seen that the steam exhausted from section B is divided, and part passes through the sub-section F and part passes through a similar sub-section G. The sections F and G exhaust into the space H, from which the steam passes into the exhaust J. In the present instance the passage K for directing the steam into the division G is formed in the walls of the stator L. At the end of the section D is a sub-section M which operates in parallel with sub-sections F and G, and may be considered a part of the section D. The number of sub-sections used is not limited to three as shown.—*July 26th*, 1917.

MINES AND METALS.

101,412 (12,396 of 1916). September 1st, 1916.—Electric Furnace, Ivan Rennerfelt, Djursholm, Sweden.

This invention relates to furnaces in which heating is effected by arcs and resistances, the furnace being divided into two or a number of chambers, one being the arc chamber and the other for receiving the charge. Fig. 1 shows a vertical cross section of the electrode chamber of one form of furnace, and Fig. 2 a vertical section at right angles to the first, also through the electrode chamber. Fig. 3 shows a detail of a feeding device for the electrode. A is an electrode or arc chamber, and B is an



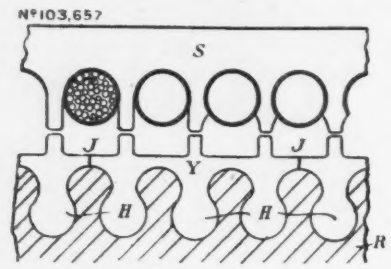
electrode in the same. The electrode generates an arc C contacting with a more or less finely divided conductor D. Below the arc a chamber E is arranged in the conductor, this chamber being formed, in the instance shown, by means of a retort or a cupel-furnace F. Below this cupel-furnace there is a conductive mass or body G in which there is an electrode H or other contact for the current forming the arc. The walls of the electrode chamber, and of the chamber E, are made from a very refractory material. For feeding the electrode downwards there is arranged on the furnace a hand wheel K on a screw L actuating an arm M, connected in suitable manner to the electrode. When the

retort or cupel-furnace is made of a material non-conducting when cold, the furnace is heated in any suitable manner before beginning the operation of the furnace to such temperature that the material becomes conductive to the electric current.—*July 26th*, 1917.

DYNAMOS AND MOTORS.

103,657 (438 of 1917). July 26th, 1916.—High Frequency Alternators, Joseph Bethenod and Emile Girardeau, 10, Rue Auber, Paris.

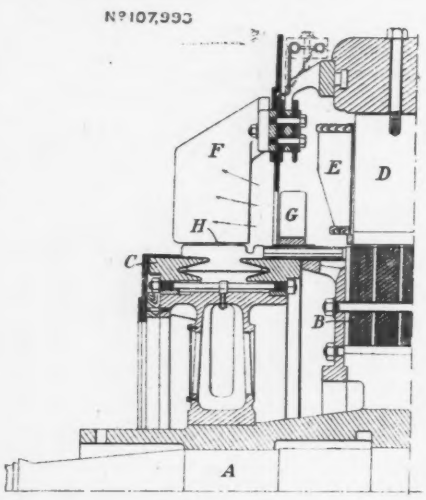
This invention relates to high-speed machines such as are used for wireless telegraphy in which it is necessary to take special precautions in order to secure the thin sheet iron segments forming the pole pieces to the drum which supports them. The magnetic part of the rotor R is formed of segments of thin



plates Y provided with teeth and held in place by means of tenons H, the radii of the curved portions of the tenons being approximately equal to the height of the teeth forming the polar projections and the number of tenons being either independent of or dependent on the number of the teeth. S is the stator. The thin iron sheets are separated from one another by joints J.—*July 26th*, 1917.

107,993 (5842 of 1916). April 20th, 1916.—Dynamos, British Thomson-Houston Company, Limited, 83, Cannon-street, London, E.C., and another.

The object of this invention is to prevent "flash-overs" between brushes of different potential of high-voltage dynamos and rotary converters having axial commutators. In the sectional illustration A is the armature shaft on which is shown mounted the armature core B and the commutator structure C. D is a field magnet carrying a field coil E. F is a brush holder arm

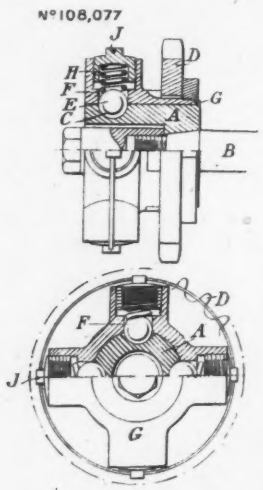


and G is an impeller fan mounted between the armature core and the commutator and adapted to force a strong blast of air over the working surface H of the commutator between the sets of commutator brushes in the direction shown by the arrows. This blast prevents the accumulation of conducting material in the space between brushes of opposite potential and thus avoids "flash-overs."—*July 20th*, 1917.

TRANSMISSION OF POWER.

108,077 (14,648 of 1916). October 14th, 1916.—Shock Absorber for Chain Gearing, Harry Stevens and others, Retreat-street, Wolverhampton.

This is a means of absorbing shocks in chain transmission

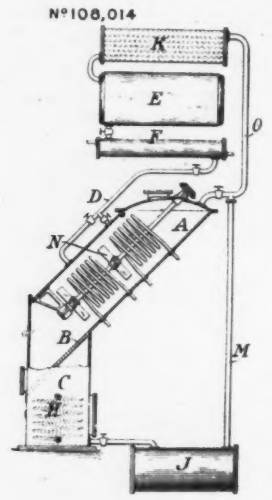


gearing; a driving sleeve A is rigidly secured to the shaft B of the prime mover, and in the sleeve are recesses C spaced round the circumference. Rotatably mounted on this driving sleeve is another sleeve G to which is fastened the chain sprocket D. Balls E are placed in the recesses of the driving sleeve, such balls lying preferably half-way in the recesses and half-way in slots or recesses in the sprocket-wheel-carrying sleeve. Spiral springs H bear on the balls and press them in the recesses of the driving sleeve, the spiral spring bearing at its other end on a cap J screw threaded into the sprocket-wheel-carrying sleeve, or cylindrical projections thereon, the caps being screwed into position from the outside. The recesses in the driving sleeve are semi-circular in section taken centrally and axially of the sleeve, but somewhat V-shaped, as seen in section taken at right-angles to the above section. Should there be a sudden increase in the driving force the balls will be forced outwardly to compress the spiral springs, which springs therefore absorb the shock.—*July 26th*, 1917.

MISCELLANEOUS.

108,014 (10,017 of 1916). July 17th, 1916.—Apparatus for the Extraction of Grease, Henri Engel, Holland House, Shoot-up-Hill, Cricklewood, Middlesex.

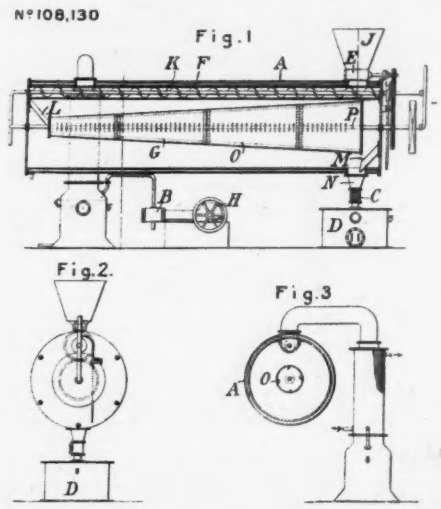
The extractor comprises a cylindrical vessel A in an inclined position, an opening in the lower end of which has a grating B through which the extracted grease passes into the chamber C. The vessel A is connected by a pipe D with a reservoir E either directly or through a heater F. There are steam coils to heat up the charge of material and also the extracting agent introduced through the pipe D. The chamber C contains steam heating coils H and is also in connection with a still J, and through the still with a condenser K. The oils or greases under the combined actions of heat and the extracting agent are extracted from the charge of material contained in the vessel A and pass therefrom



through the grid B into the chamber C, wherein they are subjected to further heating action of the coils H. Extracting agent also passes from the vessel A into the chamber C, and this agent, together with the extracted oils, are passed by gravity into the still J in which the extracting agent is separated from the oils, and is led through a pipe M to the condenser, in which it is condensed and then delivered to the reservoir E. The distillation of the oils or greases may take place under vacuum, if desired. The vessel may be fitted, if necessary, and as shown with mechanically driven stirrers N. The vessel A has also connected by a pipe O, to which the pipe M is shown connected with the condenser K, so that extracting agent in vaporous form may pass to the latter.—*July 17th*, 1917.

108,130 (3325 of 1917). March 6th, 1917.—Vacuum Drying Apparatus, John Darnley Taylor, Australia House, Strand, London, and others.

This is a vacuum drying apparatus in which by means of a rotary drum of conical formation the material is caused to travel by gravity through the drying chamber. The material is conveyed to the drum by a worm which receives it from a rotary feeding device, the arrangement being such that the material travels by gravity through the conical drum in a direction opposed to that of the travel through the worm. The method of driving the revolving apparatus is clearly shown in Figs. 1–3. Steam having been admitted to the jacket of the chamber A, and the vacuum pump B having been set in operation, the valve C



is opened to connect the receiver D with the drying chamber and the feeding plug E. The conveyor F, and conical drum G are rotated by the engine H. The material is introduced into the hopper J. As the material falls the plug E transfers it to the conveyor worm F, which passes it through the chamber K to the opposite end of the drying chamber, when it falls upon the chute L, which delivers it to the smaller end of the conical drying drum G; the latter causes the material to travel by gravity in the opposite direction, *i.e.*, towards the feed and discharge end of the drying chamber, from which it falls upon the chute M and into the hopper N and so to the receiver D. During its passage through the drum the scoops O agitate the material and throw it on to the heated shaft P and radiating fins, so that by the time it reaches the chute M it is completely deprived of moisture.—*July 26th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for The Engineer *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of the patents given below £26 have been paid in renewal fees.

No. 25,581/10.—Iron and steel; a process for improving the quality of commercial malleable iron and steel consists in covering the metal on an acid or basic hearth with an oxidising slag containing a metallic oxide, and introducing therein at intervals throughout the treatment with the slag a solid substance containing free carbon. For an acid hearth the slag may be composed of lime, sand, manganese ore, and iron ore, and for a basic hearth of lime, fluorspar and iron ore. Prior to the treatment on a basic hearth the metal may be treated with a basic non-oxidising slag for the removal of sulphur. Electrostahl Ges., Germany. Dated March 26th, 1910.

No. 25,589/10.—Electric motor control. When the emergency brake on an electrically-driven vehicle or train is applied, one or more switches automatically break the motor circuit. Allgemeine Elektricitats-Ges., Berlin. Dated November 3rd, 1909.

No. 25,622/10.—Telescopes. In tachometric telescopes in which the object-glass and measuring marks are relatively fixed, the anallatic lens is so chosen and arranged with respect to them that when set for distance it is about half-way between the measuring marks and the image of the apex of the tachometric angle projected by the objective, and, when set for near objects, it approaches the image—or in the case of a negative lens, the measuring marks—by, at the most, half the distance that originally separated them. Zeiss, C. (firm of), Germany. Dated November 10th, 1909.

No. 25,741/10.—Steel Alloys. A non-magnetic steel for use in shipbuilding or in the construction of electric measuring instruments, contains manganese and titanium together with small quantities of silicon, sulphur, and phosphorus. Kohlhaas, F., Germany. Dated November 12th, 1909.

No. 25,838/10.—Ordnance; recoil apparatus. Relates to return springs of the kind so arranged that they also act as buffers to absorb shocks at the end of run-out. According to the invention, the run-out spring is carried in a cylindrical casing connected with the barrel and guided in the cradle, and is wound over a rod fixed to the cradle, the parts being so arranged that they can be easily removed by bayonet joints without disturbing the adjustment of the spring. Rheinische Metall waaren-und Maschinenfabrik, Germany. Dated November 12th, 1909.

No. 25,879/10.—Galvanic batteries; gas batteries; chlorine; zinc and like batteries; carbon-consuming batteries. Gases to be consumed are electrically charged, negatively if oxidising, and positively if reducing, and can then react while cold. The gases may be respectively oxygen, or air, and hydrogen, ethane, methane, acetylene, coal gas, water gas, or the vapour of benzine, petroleum, alcohol, &c., the electrolyte being dilute sulphuric acid; hydrogen and chlorine may be used with hydrochloric acid solution. Braun, G., and Schneider, F., Germany.

No. 25,989/10.—Gyroscopic compasses. In a gyroscopic compass provided with a device for transmitting changes of position to a distance on the subsequent rotation principle, the card carries a flexible contact arm, which, in the event of the compass being turned relatively to the slip, makes contact with one of two ring sections insulated from each other, and then slides along inside the ring section with very little friction, while the ring is rotated in the same direction by one or other of two motors, the circuit of which is closed by the contact, until the arm again enters a gap, thus interrupting the circuit. Anschutz and Co., Germany. Dated November 9th, 1909.

No. 26,079/10.—Telephone systems; automatic and semi-automatic exchange systems. The selecting impulses sent by the calling subscriber or exchange operator are received and stored in an easily-operated switching device, which afterwards repeats them to the selectors in equal or modified number. Telephon Apparat Fabrik E. Zwietusch and Co., Germany. Dated November 10th, 1909.

No. 26,187/10—Dynamo-electric machines; pole-pieces, cores, yokes, and carcase structures. A machine for giving a high-tension voltage wave of unequal amplitudes, has an excentrically mounted H-shaped rotating magnet, with two of its pole tips close together and two widely apart. Breslauer, M., Germany. Dated November 26th, 1909.

No. 26,192/10.—Compressed-gas engines. In a system wherein illuminating or other gas drives a motor, in expanding prior to being utilised, say, at a burner, the exhaust pressure is kept uniform by means of a diaphragm subject to the exhaust pressure and connected to a throttle valve in the exhaust pipe, or in the admission pipe, or to a brake for controlling the speed of the motor. Pintsch, Akt.-Ges., J., Berlin. Dated November 16th, 1909.

Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, the 20th and 21st of September, 1917, commencing at 10.30 a.m. on the 20th, and at 10 a.m. on the 21st. The following is the list of papers that are expected to be submitted for reading and discussion:—(1) G. Barrett and T. B. Rogerson: "Present Practice in Briquetting of Iron Ores." (2) W. J. Brooke and F. F. Hunting: "Microstructure of Commercially Pure Iron between Ar_3 and Ar_2." (3) D. E. Campbell and W. C. Dowd: "The Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric-potential of some Steels." (4) G. Charpy and A. Cornu-Thenard: "New Impact Testing Experiments." (5) J. E. Hurst: "Heat Treatment of Grey Cast Iron." (6) E. F. Law: "Effect of Mass on Heat Treatment." (7) T. D. Morgans and F. Rogers: Investigation upon a Cast of Acid Open-hearth Steel." (8) F. Rogers: "The Acid Open-Hearth Process." (9) J. H. Whiteley: "The Eggertz Test for Combined Carbon in Steel." (10) E. B. Wolff: "Failure of Boiler Plates in Service and Investigation of Stresses occurring in Riveted Joints."

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The Engineer.

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VOL. CXXIV.—No. 3219] LONDON: FRIDAY EVENING, SEPTEMBER 7, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

IN THE MATTER OF THE TRADING WITH THE ENEMY AMENDMENT ACT, 1916.

The Public Trustee Invites

TENDERS for the PURCHASE, in One Lot, of 3000 ORDINARY SHARES of £10 each, fully paid, in SCHAFFER and BUDENBERG, Limited, of Broadheath, near Manchester, Manufacturers of Pressure, Speed, and Temperature Recording and Controlling Instruments, &c.

These shares represent the whole of the issued capital of the Company, and are vested in the Public Trustee as custodian by an Order of the Board of Trade, dated the 3rd day of July, 1916, made in pursuance of Section 4 of the Trading with the Enemy Amendment Act, 1916.

Before any Tender is accepted, the proposed purchaser will be required to make a statutory declaration that he is a British subject, and that he is not buying for or on behalf of a foreigner or foreign corporation or corporation under foreign control.

A Report on the past operations and the present position of the Company has been prepared for the Public Trustee by Messrs. Litton, Pownall, Blakey and Higson, Chartered Accountants, and this Report can be inspected either at their offices, No. 42, Spring-gardens, Manchester, or at the offices of the Public Trustee, Kingsway, London, W.C.

Conditions of sale and forms of Tender may be obtained at the offices of Messrs. Litton, Pownall, Blakey and Higson, or at the offices of the Public Trustee, and all Tenders will be subject to such conditions.

All Tenders must be delivered in sealed envelopes to the PUBLIC TRUSTEE on or before Twelve o'clock noon on the 1st day of October, 1917, and must be marked "Tenders Schaffer and Budenberg Co.'s Shares," and the successful tenderer will be advised of the acceptance of his Tender within one week thereafter.

The purchaser will be entitled to all profits shown by the Balance-sheet of the Company, dated the 31st day of December, 1916, and to all profits of the Company subsequently earned. 653

UNIVERSITY OF DURHAM.

Armstrong College, Newcastle-upon-Tyne.

PRINCIPAL: W. H. HADOW, M.A., D. Mus., J.P.

SESSION 1917-18.

(Commencing September 24th, 1917.)

Departments of Mechanical, Marine, Civil, and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts, and Commerce.

Full particulars may be obtained on application to—

F. H. PRUEN, M.A., Secretary,
Armstrong College, Newcastle-upon-Tyne. 358

London County Council.

DAY AND EVENING CLASSES IN ENGINEERING

(CIVIL, ELECTRICAL, MECHANICAL, AND MARINE)

are held at the undermentioned Institutions maintained by the London County Council:—

HACKNEY INSTITUTE, Dalston-lane, E.8. (MECHANICAL AND ELECTRICAL).

PADDINGTON TECHNICAL INSTITUTE, Saltram-crescent, W.9. (MECHANICAL AND ELECTRICAL).

SCHOOL OF ENGINEERING AND NAVIGATION, High-street, Poplar, E.14. (ALL, EXCEPT CIVIL ENGINEERING).

WESTMINSTER TECHNICAL INSTITUTE, Vincent-square, S.W.1. (CIVIL ENGINEERING IN THE EVENING).

In most cases persons under 21 qualified for admission to the Schools or Institutes and bona fide engaged in the trade are admitted free.

Full prospectuses may be obtained on application to the Secretaries of the respective Institutions.

JAMES BIRD,
603 Clerk of the London County Council.

South-Western Polytechnic Institute, Chelsea, S.W.3.

UNIVERSITY AND TECHNICAL DAY AND EVENING COURSES IN

MECHANICAL AND ELECTRICAL ENGINEERING.

Commence 24th September.

SCHOLARSHIPS EXAMINATION, 17th September, 10 a.m. Apprenticeship scheme for Engineers.—Prospectus on application to SECRETARY (Room 22). Telephone: 899 Western. 439

University of London.

SCHOOL OF ARCHITECTURE.

DAY COURSES.

The University School of Architecture at University College provides a thorough training for Students wishing to enter the Architectural Profession, as well as for those who have already had some experience.

The Day Courses for the B.A. Degree (Honours in Architecture) extend over three years. The Course for the College Certificate in Architecture extends over two or three years.

Students who take their Degree, or who receive a First-class College Certificate, are exempted from the Intermediate Examination of the Royal Institute of British Architects.

Special Courses for advanced Students can be taken by the Term or Session.

EVENING CLASSES.

The Carpenters' Company Evening Class in Design has been suspended for the duration of the War.

In the DEPARTMENT OF TOWN PLANNING, conducted under the direction of Professor S. D. ADSHEAD, M.A., F.R.I.B.A., Students can work in the day or in the evening, or partly in both.

Those who satisfy the conditions may obtain a Certificate in Town Planning, or a University Diploma either in Town Planning and Civic Architecture, or in Town Planning and Civic Engineering.

The Session 1917-18 opens on Monday, October 1st.
For pamphlet giving further information apply to
WALTER W. SETON, M.A., D.Lit.,
Secretary,
University College, London.
(Gower-street, W.C.) 651

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic Institute,

St. John-street, London E.C.

ENGINEERING DAY COLLEGE.

Full Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering will commence on Monday, 1st October, 1917. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and Aeronautical Engineering, and those in Electrical Engineering include specialisation in Radio-Telegraphy.

ENTRANCE EXAMINATION on Tuesday and Wednesday, 25th and 26th September, 1917. These courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees, £15 or £11 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £52 each will be offered for competition at the Entrance Examination in September, 1917.

TECHNICAL OPTICS.

Full and Part-time Courses in this important department of Applied Science will be given in specially equipped laboratories and lecture-rooms. An AITCHISON SCHOLARSHIP (value £30) will be offered in this department at the Entrance Examination.

Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute, or on application to

R. MULLINEUX WALMSLEY, D.Sc.,
423 Principal.

THE MANCHESTER MUNICIPAL

SCHOOL OF TECHNOLOGY

UNIVERSITY OF MANCHESTER

(FACULTY OF TECHNOLOGY).

DEGREE COURSES IN TECHNOLOGY.

The Prospectus gives particulars of the courses leading to the Manchester University degrees (B.Sc. Tech. and M.Sc. Tech.) in the Faculty of Technology, in the following Departments:—

MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING,
SANITARY (including Municipal) ENGINEERING.
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Dyeing, Bleaching, Calico Printing, Papermaking, Metallurgy, Fuels, Fermentation Industries).
THE TEXTILE INDUSTRIES,
PRINTING AND PHOTOGRAPHIC TECHNOLOGY.
ARCHITECTURE.

ADVANCED STUDY AND RESEARCH.

The School of Technology possesses extensive laboratories and workshops, equipped with full-sized modern machinery and apparatus, including not only machines of the patterns in general use, but also machines specially constructed for demonstration and original research.

Prospectuses of the University Courses, or of the Part-time Courses, will be forwarded free on application to the Registrar. 17

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M. Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE, comprising

FACULTIES OF ENGINEERING AND METALLURGY.

PROFESSORS IN THE DEPARTMENT.

Mechanical Engineering	W. RIPPER, D.Eng., D.Sc., M. Inst. C.E.
Metallurgy	J. O. ARNOLD, D.Met., F.R.S.
Mining	F. E. ARMSTRONG, M.Sc., A.M. Inst. C.E.
Applied Chemistry	L. T. O'SHEA, M.Sc.
Mathematics	A. H. LEAHY, M.A.
Physics	S. R. MILNER, D.Sc. (Acting Prof.)
Chemistry	W. P. WYNNE, D.Sc., F.R.S.
Geology	W. G. FEARNSIDES, M.A.
Electrical Engineering	E. H. CRAPPER, B.Eng., M.I.E.E (Lecturer).
Civil Engineering	J. HUSBAND, B.Eng., A.M. Inst. C.E. (Lecturer).
Glass Technology	W. E. S. TURNER, D.Sc. (Lecturer).

The subjects in which courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes courses in Civil, Mechanical, Electrical and Chemical Engineering, and students specialise in one or other of these branches in the third year of their course. The course in Engineering extends over three years and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' courses are arranged for Works' Pupils, who come to the University from works in Sheffield, or from other centres, taking six months' study at the University and six months' practice at the works each year.

The DEPARTMENT OF METALLURGY includes (a) the Metallurgy of Iron and Steel, and (b) the Metallurgy of the Non-ferrous Metals. The course in Metallurgy extends over three years, and prepares for the Degree of Bachelor of Metallurgy (B.Met.) or for the Associateship of the University in Metallurgy. The equipment of this Department is on an exceptionally complete and practical scale.

The work of the DEPARTMENT OF COAL MINING includes a three or four years' Diploma Course, consisting of six months at the University and six months at a Colliery.

The DEPARTMENT OF APPLIED CHEMISTRY deals specially with the subjects relating to various branches of Coal Mining, and of the Coal and Coke Industries.

The DEPARTMENT OF GLASS TECHNOLOGY provides (a) a Diploma Course requiring systematic study of the science and practice of Glass Manufacture for a period of three years, and (b) Part Time and Special Courses.

The LECTURE COURSES of all the Departments are supplemented by Practical Training in Laboratories, Workshops, and Foundries fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part Time Courses are arranged for students who desire to take special portions of any of the regular courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917.

W. M. GIBBONS,
139 Registrar.

Kent Education Committee.

APPLICATIONS are invited from persons possessing good Engineering qualifications for the POST of DIRECTOR FOR FURTHER EDUCATION in the towns of Ashford, Folkestone and Hythe.

The person selected will be required to organise the Further Education work in the above-mentioned towns and to act as Secretary to the local Sub-committees for Higher Education.

The salary will be fixed according to qualifications and experience, but will be not less than £250 a year.

Forms of application can be obtained from the undersigned, and must be returned not later than Wednesday, 26th September, 1917.

FRAS. W. CROOK, Secretary.
Sessions House, Maidstone,
5th September, 1917. 660

Wigan and District Mining and Technical College.

APPLICATIONS are invited for the following VACANCIES for Day and Evening Classes:—

1. LECTURER IN MECHANICAL ENGINEERING SUBJECTS.
2. LECTURER IN MATHEMATICS (ability to take charge of classes in Elementary Physics will be an additional recommendation).

Salary in each case £150, rising by £10 annually to £180, together with war bonus of 10 per cent.

Further particulars can be obtained from the undersigned, to whom applications should be addressed as early as possible.

S. C. LAWS, M.A., B.Sc.,
Principal. 659

Association of Engineering and Shipbuilding Draughtsmen.

POST OF ORGANISING SECRETARY.

The Representative Council of the Association of Engineering and Shipbuilding Draughtsmen invite

APPLICATIONS FOR THE POST OF GENERAL SECRETARY.

The salary attached to the post is £350 per annum, rising by increments of £25 to a probable maximum of £400.

The successful candidate must be prepared to give his entire services to the office, and to reside in Glasgow until 1st March, 1918, when headquarters will be removed to London.

Six months' notice in writing to terminate the agreement on either side.

Applications should state age, qualifications and organising ability, and six copies should be forwarded, not later than 21st September, to the SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 94, Hope-street, Glasgow.

Envelopes to be marked "G. S." 600

North Bromsgrove Urban District Council.

WANTED, a competent MAN, to Take Charge of Gas Engine, Pumping Plant, and Sewage Disposal Works (ineligible), to take place of man required by Ministry of Munitions.

Full particulars, with wages asked, to FRANCIS T. LEVENS, 110, High-street, Bromsgrove. 618

The Port of London Authority

REQUIRE the SERVICES on the Temporary Staff of several DRAUGHTSMEN thoroughly experienced in the design and construction of one or more of the following branches of Engineering:—

(a) Heavy Movable Bridges and Steelwork.
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(c) Docks, Entrances, Passages, Walls, Jetties, &c.
(d) Railways.
(e) Mechanical Appliances.
(f) Hydraulic Installations.

State age and salary required, medical category (if of recruitable age), present salary and employment, and when at liberty.—Apply by letter only to the CHIEF ENGINEER, 109, Leadenhall-street, E.C. 3. 587

Commissioners for the Port of Rangoon.

FOR SALE:—TWIN SCREW, STEEL, SELF-PROPELLING SUCTION DREDGER, "PELICAN," and FLOATING PIPE LINE, built by Messrs. W. Simons and Company, Renfrew, 1908.

DREDGER.—Length 208ft. by 36ft. beam; maximum draught 10ft. 7in.

Two sets triple expansion surface condensing propelling and two sets pumping engines, with 4 boilers; two 30in. centrifugal pumps with nominal capacity of 80,000 cubic feet of sand or silt per hour, lifting from a depth of 35ft. and delivering through 3000ft. of pipe line.

FLOATING PIPE LINE.—In 58 lengths of steel pipe, 50ft. long and 42in. diameter, on circular steel pontoons, 26ft. diameter and 4ft. 4in. deep.

Further particulars may be obtained from

The SECRETARY,
Commissioners for the Port of Rangoon,
520 Post Box No. 85,
Rangoon, Burma.

Wanted, Immediately, Man to take Charge of Department doing simple Repetition Lathe Work, used to Cutting-off Machines.

Strict, tactful disciplinarian; 6 o'clock man. No person already employed on Government work will be engaged.—Give full particulars of experience and wages required to your nearest Employment Exchange, mentioning "The Engineer" and No. A3632. 620 A

Wanted, One or More Commercial Engineers

who have Experience in Overseas Business and a Knowledge of Continental Languages, for Re-Opening Trade Operations After the War, by the ORGANISERS OF CLARING HOUSE, Parliament Mansions, Victoria-street, Westminster. Government employés cannot be entertained at present, but may lodge their qualifications for use when the time comes.—Apply, by letter only, to the above address. 640 A

Wanted, the Services of a Highly trained TECHNICAL ENGINEER

for a short period, for the purpose of compiling a technical catalogue illustrating the manufactures produced by a very large firm, and containing useful information for Engineers, Architects, Builders, &c. Liberal terms to suitable man.—Address, 551, "The Engineer" Office. 551 A

Wanted, Working Engineer (Ineligible

for the Army) to take charge of and work Oil Engines on Estate Works, Well pumps, Water Supply (h. and c.) and the Engineering work arising out of an Agricultural Estate. Good references as to ability, experience and personal character essential. Good house and firing provided.—Apply, stating wages required and all particulars, to Messrs. G. WEBB and CO., Land Agents, Sittingbourne. 619 A

Works Engineer Required for

a large Shipbuilding and Engineering Works. Must be a thoroughly experienced man and capable of taking complete control as regards the maintenance and upkeep of the Works Plant, Power Station, Hydraulic and Pneumatic Services, Cranes, &c.—Address, stating age, previous experience, and salary required, to 571, "The Engineer" Office. 571 A

Inspectors Required Immediately

for Government Controlled Aircraft Factory. No one at present on Government work will be engaged.—Apply, stating age, experience and salary required, through nearest Employment Exchange, mentioning "The Engineer" and number 668. 668 A

Wanted,

BY THE

HEATLY-GRESHAM ENGINEERING CO., Ld.,

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IRON CASTINGS

from 28 lb. up to One Ton. 639 A

Electrical and Mechanical Engineer

accustomed to laying out plant for rolling mills, wire drawers, &c., and able to make own plans. State age, experience, and wages required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and No. A3581. P918 A

Electrical Power Engineer, with

experience in A.C. and D.C. Motor Factory Equipments, preferably with drawing-office or test experience, for large manufacturing firm (controlled).—Apply, stating experience, age, and salary required, to your nearest Employment Exchange, and quote "The Engineer" and No. A3537. No person already engaged on Government work need apply. 511 A

Engineer for Power Station

WANTED. Engineer to Take Charge of the Erection and afterwards the Running of big Central Power Station with Water-tube Boilers and Steam Turbines. Previous experience in large central station generating 3-phase high-tension alternating current essential. Candidates employed upon Government work will not be engaged.—Apply, stating age, salary required, and experience in full, to your nearest Employment Exchange, quoting "The Engineer" and No. A3537. 621 A

Engineer Required, Thoroughly

acquainted with Cocoa Grinding Mill and Presses. Good pay to an expert man. State age, references and wages expected.—Address, 635, "The Engineer" Office. 635 A

First-class Experienced Estimator

WANTED by Government-controlled works making large and small engines, repetition and general work. Man with thorough practical knowledge of Machining, Fitting, and Foundries, &c., who could organise and control a department dealing with rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 15. 15 A

Man to Take Charge of Rate-fixing

in large Engineering Works in the Midlands employing 1500 people. Applicants must be used to large, medium, and small work, modern methods, and not already engaged on Government work. Progressive job to right man.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3629. 638 A

Manager Wanted for the Midlands,

thoroughly competent to UNDERTAKE CONTROL of the Manufacture of Milling Cutters, Reamers, Hobs, Gear Cutters, &c., of all descriptions, from the blank to the finished tool. Must be experienced in handling both male and female labour, able to fix rates, and capable of introducing the most up-to-date methods of production.—Write, stating full details of experience, also age, and salary expected, to U.G.C., c/o Streets, 30, Cornhill, E.C. 3. 519 A

Men Required for Planning and Progress

Departments in London Aeroplane Factory, preferably with practical experience in Engineering. Also Men with good knowledge of Drawings and Estimating Quantities. No person already engaged on Government work, or resident more than ten miles away, need apply.—Address, 631, "The Engineer" Office. 631 A

Rate Fixer Wanted for Engine Works.

Accustomed to modern machine methods for medium and heavy classes of work. Apply with full particulars as to experience and wages expected. Good opening for experienced man. No one already on Government work need apply.—Apply your nearest Employment Exchange, mentioning "The Engineer" and No. A3567. P921 A

Required, a Thoroughly Experienced working charge ENGINEER

for a Roofing Felt and Asphalte Factory. One with a good general millwright's experience preferable. The appointment is for a permanency. Adequate assistance is given, all light repairs being executed in an equipped small engineering shop in the factory. Position East End of London. Applicants must show first-class credentials and be unquestionably experienced.—Address, in the first place, with full particulars as to capabilities, 502, "The Engineer" Office. 502 A

Young Man (Ineligible or Discharged)

REQUIRED immediately in Works Manager's Office at Government Controlled Aircraft Establishment. Must have had sound works experience, be capable of assisting in details, and able to take responsibility of office routine. No person at present on Government work will be engaged.—Apply, stating full particulars of experience, through nearest Employment Exchange, mentioning "The Engineer" and number 641. 641 A

Wanted, Confidential Clerk for Manager's Office,

large engineering firm in Manchester district. Good stenographer, accustomed to engineering terms. Up-to-date office arrangements, &c. No one already on Government work will be engaged. State age, full details of experience, and salary required.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3566. 497 A

Wanted for Government Controlled Works, North London,

capable Male or Female COST CLERK. Must have experience in Engineering works. No one resident more than ten miles away or already on Government work will be engaged.—Apply in writing, giving fullest particulars, to 654, "The Engineer" Office. 654 A

Works Accountant Required for

a large Motor Vehicle Works employed solely upon Government work; must have had good experience in the organisation and running of an up-to-date Cost Department. No one at present engaged upon Government work can be employed.—Apply, giving particulars of experience and salary expected, to the nearest Employment Exchange, quoting "The Engineer" and number 597. 597 A

First-class Accountant Wanted,

exempt from military service. One with experience of Engineering Costing preferred. Good salary to a competent man.—Write, Box No. H.S. 142, care of Jackson's, 19, Cullum-street, E.C. 3. 629 A

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46, Watling-street, LONDON, E.C.
Albert-square, Manchester.
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SMALL ADVERTISEMENTS

SITUATIONS, FOR SALE, &c., PAGES II., III., XC.

Numerical Index to Advertisements, PAGE LXXXIX.

Assistant Costs Clerk Required, thoroughly experienced in Iron and Steel Works Costs. Must be ineligible for Military Service. Good salary will be paid to competent man. No person already on Government work will be engaged.—Apply, stating age, and giving full particulars of experience and salary required, to your nearest Employment Exchange, quoting "The Engineer" and No. A3627. 611 A

Important Association of Agri- CULTURAL ENGINEERS REQUIRES the WHOLE TIME SERVICES of a SECRETARY to act with Executive Council in developing the usefulness of the Association to its Members for Post-war Trade. Competent knowledge of Commercial Conditions in Foreign and Colonial Markets is necessary, together with ability to place before the Members up-to-date information on all important Trade and Legislative matters affecting their interest.—Please reply to 647, "The Engineer" Office, stating age, present position, experience, &c. 647 A

Experienced Chemist Wanted for Foundry casting Non-ferrous Alloys.—CLIFFE, Gt. Brook-street, Birmingham. 628 A

Wanted, Draughtsman for Motor Wagon Works (steam). State salary required, age, and full particulars. No person already on Government work will be engaged.—Apply nearest Employment Exchange, quoting "The Engineer" and No. A3457. 649 A

Wanted, Good Jig and Tool DRAUGHTSMAN for Aeroplane Engine Work.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3614. No persons already on Government work need apply. 581 A

Wanted Immediately, Draughts- MEN capable of designing Jigs and Tools for high-class Engineering.—Apply, stating experience, to your nearest Employment Exchange, quoting "The Engineer" and No. A3614. No persons already on Government work need apply. 609 A

Architectural Draughtsman, having good General and Steelwork experience, WANTED at Perth. Must be ineligible for the Army.—Apply by letter, stating particulars, age, salary, and enclosing copy testimonials, Box No. 840, c.o. Street's, 8, Serle-street, W.C. 668 A

Chief Lady Tracer Required to Take Charge of small Tracing Department on Government work in South of England. Only those who have had charge of a tracing staff for at least one year need apply.—Apply, stating age, experience, and present salary, and enclose sample of work, to nearest Employment Exchange, mentioning "The Engineer" and No. 566. No one at present on Government work will be engaged. 566 A

Constructional Engineers' DRAUGHTSMAN; knowledge of Reinforced Concrete desirable. No person employed on Government work will be engaged.—Apply, stating age, salary required, and experience, to your nearest Employment Exchange, quoting "The Engineer" and No. A3639. 625 A

Draughtsman, Junior, Mechan- ICAL, WANTED by Midland firm, manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application, in the first instance, should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3634. 12 A

Draughtsman, Mechanical, One used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary, according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest Employment Exchange, mentioning "The Engineer" and No. A3360. 124 A

Draughtsmen (Two) Wanted, used to Gauges and Testing Fixtures for Aeroplanes. No one already engaged on Government work eligible.—Apply, stating full particulars, to your nearest Employment Exchange, quoting "The Engineer" and reference No. A3630. 617 A

Draughtsman Wanted by Manu- FACTURERS of Gas Producers, Furnaces, Chemical and Gasworks Plant, &c. State full particulars of experience and salary required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 664. 664 A

Draughtsman Wanted, Familiar with Lay-out of Engineering Works; to prepare plans for re-arrangement and extensions. State experience and salary. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 646. 646 A

Draughtsmen Wanted, Tho- ROUGHLY capable, for Large Blast Furnace and Steel Works Plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply your nearest Employment Exchange, quoting "The Engineer" and No. A3295. 13 A

Draughtsmen Wanted.—Three LEADING DRAUGHTSMEN capable of taking full responsibility for accuracy of plans and supervision of juniors, and THREE ASSISTANT DRAUGHTSMEN; experience in installation of oil works and power plant an advantage; quickness and accuracy of work essential. Candidates employed on Government work will not be engaged.—Apply, stating age, salary required, and experience in full, to your nearest Employment Exchange, quoting "The Engineer" and No. A3636. 622 A

Experienced Ship and Pipe ARRANGEMENT DRAUGHTSMAN WANTED for Marine Engine Works on the N.E. Coast. Permanency to good man. State age, experience, and salary required. No one already employed on Government work will be engaged.—Applications to be made to the nearest Employment Exchange, mentioning "The Engineer" and number 615. 615 A

Jig and Tool Draughtsman REQUIRED by small Tool Department of Government controlled establishment. Applicants should have had shop training and some Drawing-office experience, preferably in Design of Labour-saving Tools. Permanent position and good prospects to suitable man. State age, experience, salary required, and when at liberty, and apply in first instance to your nearest Employment Exchange, quoting "The Engineer" and No. A3605. No person already on Government work will be engaged. 582 A

Locomotive Draughtsmen Re- QUIRED for works in the North of England. State age, salary required, and details of previous experience. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 604. 604 A

Several Lady Tracers Required for South of England.—Apply, stating age, experience, present salary, and enclose sample of work, to nearest Employment Exchange, mentioning "The Engineer" and number 567. No one at present on Government work will be engaged.

Several Mechanical Draughts- MEN, with experience in Deck Machinery and Ship Engineering and Fittings, REQUIRED for Admiralty work. Commencing salary according to experience.—Apply, stating age, experience, and present salary, to nearest Employment Exchange, mentioning "The Engineer" and No. 565. No one at present on Government work will be engaged. 565 A

Wanted, Foreman for Brass- FINISHING Department of Engineering Works in Manchester district; must be thoroughly acquainted with latest methods of production and have good command over men and women. Permanent situation to suitable person. State age, experience, and wages required. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 667. 667 A

Assistant Foreman Required for Modern Tool Room. Must be thoroughly conversant with the manufacture of Modern Small Tools. State full particulars as to experience, age, wages, and when at liberty. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 657. 657 A

Required, Outside Representa- TIVES, with initiative and knowledge of Engineering Accessories, for London Aeroplane Factory. No person resident more than ten miles away, or already on Government work, need apply.—Reply, stating age, full particulars of qualifications, and salary required, to 630, "The Engineer" Office. 630 A

Wanted Immediately, Fitters and GRINDERS for Gauge and Tool work in N.E. London. No persons already on Government work need apply.—Apply to nearest Employment Exchange, quoting "The Engineer" and No. A3612. 610 A

Aluminium and Brass Moulders REQUIRED immediately for Government Controlled Establishment.—Apply through nearest Employment Exchange, stating experience, age and salary required. No one at present employed on Government work will be engaged. Mention "The Engineer" and number 624. 624 A

Die Sinker. — First-class Die SINKER for Heavy Drop Stampings, including Motor Cranks and Aircraft work. Permanent situation. Give full particulars as to wages, &c. No person already employed upon Government work will be engaged.—Applicants must apply to their nearest Employment Exchange, mentioning "The Engineer" and number 670. 670 A

Fitters Required Immediately for Government Controlled Aircraft Factory. No person at present on Government work will be engaged. Application must be made through the nearest Employment Exchange, mentioning "The Engineer" and number 642. 642 A

Mechanical Excavator Operator WANTED for work in Northern Nigeria.—Write, giving full particulars of experience, age, wages required, &c., to "C. K.," c.o. J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 627 A

Advertiser (25), C 3, and Re- QUIRED to do work of National Importance, DESIRES ENGAGEMENT IN SHELL FACTORY, MUNITION WORKS, or other works of National Importance. Engineering student at Birmingham University for two years. Public school education.—Address, P938, "The Engineer" Office. P938 B

Aero Engine Manufacturer (Works or General Manager) is OPEN to OFFER from progressive firm. Proven organiser and expert in lay-out and plant equipment, and specialist in heat treatment of alloy steels to B.A.F. and Admiralty specifications; with good production record in manufacture of rotary and stationary engines.—Address, P912, "The Engineer" Office. P912 B

Architect, Qualified (43), 25 years' first-class experience, last eight months important engineering buildings, canteens, &c., LIBERTY after month's notice.—Address, P937, "The Engineer" Office. P937 B

Civil Engineer (Ineligible) Re- QUIRES POSITION. Many years' experience in office and on works, on railways, bridges, warehouses, &c. Good surveyor and draughtsman. Calculations and quantities. Will go abroad.—Address, P972, "The Engineer" Office. P972 B

Civil Engineering Student (Chinese), with 4½ years technical and practical training, DESIRES EXPERIENCE in the Design and Construction of Reinforced Concrete—also Heavy Steelwork—with firm of Engineers or Contractors in London.—Address particulars, &c., P934, "The Engineer" Office. P934 B

Electrical Engineer Desires Post with small controlled firm as OUTSIDE ERECTOR or TECHNICAL REPRESENTATIVE. Experiences three years works, seven years designing, contracting and sales offices. Salary £300.—Address, P964, "The Engineer" Office. P964 B

Engineer, Englishman, Speaking fluent French, having completed apprenticeship, DESIRES POSITION with scope for advancement. Speciality, constructional marine work.—Address, P955, "The Engineer" Office. P955 B

Engineer, having had Several years' experience as chief draughtsman and works manager in general engineering and boiler-making, is OPEN to ENGAGEMENT. Age 42. Good references.—Address, 655, "The Engineer" Office. 655 B

Engineer, Just Completed premium apprenticeship, including drawing-office, DESIRES POSITION. Experienced in internal combustion, including aero engines, and general engineering.—Address, P988, "The Engineer" Office. P988 B

Engineer Mech. (over Military age); good draughtsman; experienced in the erection of steam engines, boilers, and steel rolling plant. Specialist in the design, erection, and management of jute, spinning, and weaving mills. Can take full control, and can conduct labour in Portuguese and Hindustani languages.—Address, P960, "The Engineer" Office. P960 B

Engineer, Mech. (45), 30 Years' sound practical exp. Marine and General Engineering Assistant W.M. and Works Organiser. SHORTLY DISENGAGED. Midlands or South preferred.—Address, P946, "The Engineer" Office. P946 B

Engineer (29), Wh. Ex., with thorough practical, technical, and commercial experience, is FREE for APPOINTMENT as DEPARTMENTAL or ASSISTANT WORKS MANAGER. London district preferred.—Address, P975, "The Engineer" Office. P975 B

Engineer (35), Ineligible for Army, REQUIRES Responsible POSITION. Nine years in shops and office marine engineering, ten years abroad on design, erection and maintenance of mining plants. Sound technical knowledge, undoubted ability, can handle commercial and technical correspondence.—Write, Box 952, Reynell's, 44, Chancery-lane, W.C. 2. 650 B

Engineer, 36 (Ineligible); Tho- ROUGHLY practical; 20 years' experience; mechanical, electrical, aeronautical; efficient works management; RESPONSIBLE POSITION REQUIRED.—Address, P983, "The Engineer" Office. P983 B

Estimator and Rate Fixer De- SIRES CHANGE. Sound practical shop and commercial experience of up-to-date production methods and high-class work. Familiar with both premium bonus and piecework systems.—Address, P961, "The Engineer" Office. P961 B

French Engineer, with Extensive connection, DESIRES REPRESENT High-class English or American Firms for SPECIALITIES. English Correspondence and Draughtsmen.—Address, 650, "The Engineer" Office. 650 B

Mechanical and Electrical Engi- NEER, with wide practical and commercial experience, OPEN for POSITION. Good organiser, designer, and successful inventor. Energetic and resourceful. Accustomed to full charge. Last 18 months with large American company. Returning September—free October. First-class references. Inquiries invited.—Address, P944, "The Engineer" Office. P944 B

Mechanical Engineer Seeks SITUATION (ASSISTANT or WORKS MANAGER). Wide experience in all branches; drawing-office, estimating, and production. Specialised in production of aero engines in large quantities.—Address, P956, "The Engineer" Office. P956 B

Position as Mechanical Engineer or WORKS MANAGER. Up-to-date experience in all departments, general and agricultural engineering. Good draughtsman. Full knowledge of jigs and moulding machines, shell production; 20 years manager. Over military age. Best references.—Address, P959, "The Engineer" Office. P959 B

Position Required, Mechanical and ELECTRICAL ENGINEER; first Board of Trade Certificate; year's sea and power station exp. as engineer and erector; rolling mill, high-speed and condensing, Corliss valve, gas and producer plant, evaporators, motor car, engines, various class of pumping plant, Babcock, Cornish and various other boilers.—Address, P966, "The Engineer" Office. P966 B

Production Engineer, Expert in Jig and Tool Design; well up in Machining Operations, DESIRES ENGAGEMENT. Aero Engine Work Speciality.—Address, P966, "The Engineer" Office. P966 B

Production Engineer Shortly OPEN for ENGAGEMENT. Wide experience in production. Organiser, modern methods.—Address, P971, "The Engineer" Office. P971 B

Two Engineers Desire Positions. Experienced in up-to-date methods of tooling automatics, combination lathes and all kinds of rapid production machinery. Would be satisfied with nominal salaries provided there are prospects of realising fair bonus on output. At present holding responsible positions.—Address, P985, "The Engineer" Office. P985 B

Works Manager or Superinten- DENT, at present Disengaged, SEEKS ENGAGEMENT with first-class firm. Last control 1600 hands (male and female), on Manufacture of Motor Vehicles and Shells. Previous experience, Guns, Mountings, &c. First-class organiser and strict disciplinarian.—Address, P970, "The Engineer" Office. P970 B

TO AEROPLANE MANUFACTURERS.

Young Capable Engineer is DESIROUS of obtaining a RESPONSIBLE POSITION in an Aeroplane Factory, fully conversant with up-to-date methods. First-class references. At present in charge of Aeroplane Factory employing considerably over one thousand hands. South Coast or London district preferred.—Address, P967, "The Engineer" Office. P967 B

Draughtsmen. — Junior and LEADING DRAUGHTSMAN REQUIRED by Westminster District Firm, with good mechanical training. Preference given to men with experience in Steelworks Charging Machinery or Electric Crane Work. No person already on Government work will be engaged.—Apply to your nearest Employment Exchange, quoting "The Engineer" and No. A3647. P973 B

Draughtsman, Mech., 17 Years' General Engineering, OPEN to take on SPARE TIME WORK, London.—Address, P962, "The Engineer" Office. P962 B

Clerk Desires Position as Secre- TARY or CONFIDENTIAL CLERK; highest references, thorough all-round office training; also has had practical experience through (Rly.) Engineering Shops. Ineligible for military service. Permanency required.—Address, P969, "The Engineer" Office P969 B

Foreman Boilermaker or Plater (33) DESIRES CHANGE; 8 years foreman; several years with present firm. 200 men. Considerable experience in various classes of work.—Address, P978, "The Engineer" Office. 978 B

A Large Firm of Engineers in the Midlands HAVE an OPENING for a YOUTH of Good Education as PREMIUM PUPIL, the course to include both Works and Drawing-office. Address, 2002, "The Engineer" Office 2002 B

Rapid Coaching: London Matric, Cambridge, Oxford Senior, &c., and all Engineering Exams. Easiest and up-to-date method. Success assured. Moderate terms.—Write, P977, "The Engineer" Office. P977 B

Inst. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G.P. KNOWLES, B.Sc., A.M.Inst.C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Hundreds of successes during the past twelve years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. 238 B

Penningtons, Engineering Tutors Postal Courses in Mechanical Engineering, also A.M.I. C.E., and A.M.I.M.E. Introductory Course in Engineering Mathematics and Mechanics.—254, Oxford-road, Manchester. 2012

A London Company of Sound financial standing having large warehouse and a first-class connection amongst merchants (home and export), DESIRE to HEAR from MAKERS of SPECIALITIES usually bought by Tool Factors, Mill Furnishers, and Wholesale Ironmongers, with a view to act in the after-war period as Representatives, or would contract for the whole output, acting as Wholesale Distributing Agents. Advertisers have information a branch in allied European countries, so as to be prepared for the after-war trade. Agency for any country also entertained. All negotiations to be mutually confidential. Address, 6, "The Engineer" Office. 6 D

Advertiser, Engineer with Ex- TENSIVE connection in Chemical, Colour, Dye, Explosives, and Engineering Works, travelling whole of England and Scotland, DESIRES additional first-class ENGINEERING AGENCIES; machinery or materials. Energetic and sound business man. Commission only.—Replies in strict confidence to F, 405, Smiths' Advertising Agency, 100, Fleet-street, E.C. 4. 612 D

Engineer, Well Known in Ship- PING Circles, with offices in centre of London shipping, DESIRES AGENCY for first-class Shipbuilders, Ship Repairers, or Marine Engine Builders. Highest references.—Address, P968, "The Engineer" Office. P968 D

Light Castings.—Two Gentle- MEN, holding important managerial appointments, and with practical experience in the manufacture and selling on a large scale of several proved profitable lines for which there is an increasing demand, would JOIN PROGRESSIVE COMPANY already formed or to be formed. Seats on the Board required.—Write Box 11 at Horncastle's, 60, Cheapside, E.C. 2 P976 C

Beet Raw Sugar Factories.— Design of total arrangement, Buildings and Machinery. Estimate and Supervision of Erection.—Apply to R. Th. KREUTZFELDT, Consulting Engineer (Member of Society of Danish Civil Engineers), Nr. 8, Raadhusstraede, Copenhagen, Denmark. P963 I

Wanted, Hydraulic Jigger Hoist, suitable for 10 cwt. load, to hoist about 60ft. Working pressure 700 lb. per square inch.—Address full particulars to Messrs. W. ROWLANDSON and CO., Engineers, Boundary-street, Liverpool. 637 F

Wanted, Portable Paraffin Pump, with 20ft. of Suction Pipe, that can Draw Water from 20ft. deep.—Apply, HALL and CO., Ltd., Morden-road, Mitcham. P968 G

Wanted, Time Register, Any make; must be in good working order. State make and lowest price.—Box T.R., Smith's Agency, Ltd., 100, Fleet-street, E.C 1 F

Wanted to Purchase, a Ryder FORGING MACHINE, in good working condition; also a BULLDOZER.—Address, 666, "The Engineer" Office. 666 F

Weighbridge.—Wanted, a Good SECOND-HAND 20-Ton WEIGHBRIDGE, with 18ft. by 8ft. platform.—State age, maker, condition, with full particulars and price, to BRITISH MARGARINE TRADE SUPPLIES, Ltd., Morpeth Refinery, Birkenhead. 616 F

A Firm of Manufacturing Engineers in the Midlands DESIRES to PURCHASE Two SECOND-HAND STEAM GENERATING SETS, each about 500 K.W.; D.C., voltage about 460.—Please supply full particulars to Box B974, c.o. W. H. Smith and Son, Lichfield-street, Wolverhampton. 974 F

Tar Stills Wanted, New or Second-hand.—Apply Box T. S. E., c.o. Advertisement Department, Central News, Limited, 5, New Bridge-street, London, E.C. 4. 613 F

10-Ton Portable Steam Crane WANTED, 4ft. 8½in. gauge; in good order.—Price and where seen, address 672, "The Engineer" Office. 672 F

Boilers.—For Immediate De- LIVERY, Two high-class LANCASHIRE BOILERS, 30ft. by 8ft.; just passed for reinsurance at 100 lb. pressure; no cross tubes.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence Hill, Bristol. Telegrams: "Piston, Bristol." Telephone: Bristol, 139 614 G

Bricks for Sale, Common Pressed, re-pressed facing and Engineering Bricks. Prompt deliveries.—For prices apply, MATTHEW KIRTON and SONS, Ltd., Newburn-on-Tyne. 549 G

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c. 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London S.E. Telephone No. 978 Hop. 822 G

For Sale:—

One HYDRAULIC PRESS, with 12in. ram, 29in. by 24in. platen, double hand pump, made by Middleton; short stroke.
One ditto, 9in. ram, single pump.
One ditto, 6in. ram, double pump.
Nine Belt-driven AIR COMPRESSORS, by Reavell, each four cubic feet capacity, and two ditto by Johnson, each 5 cubic feet capacity.
One Askhams "TIGER" MILL for grinding into powder light refractory material.
Also two 34in. Sherwins DISINTEGRATORS.
One Belt-driven Player's POWER HAMMER, 7in. stroke.
One CAST IRON TANK, 14ft. dia. × 6ft. deep.
Two ditto, 10ft. diameter × 4ft. deep.
One 40 B.H.P. COMPOUND HORIZONTAL ENGINE, by Davey, Paxman; 9in. and 12in. by 12in. stroke.
One 70 B.H.P. Robey HORIZONTAL ENGINE, 15in. cylinder × 26in. stroke, with expansion gear.
Two sets of Worthington Vertical Tandem Compound FEED PUMPS, each 2000 gallons per hour.

GEO. COHEN, SONS AND CO.,
600, Commercial-road,
London, E. 14. 2012 B

For Sale:—

PAIR CAPSTAN ENGINES, cyls. 9in. by 16in., worm-geared 40 to 1, with two drums.
PAIR DITTO, 8in. dia. cyls. by 12in. stroke, with drum 3ft. 6in. dia. by 3ft. wide, worm geared, &c.
WORM-GEARED CAPSTAN, 5½in. dia. cyls. by 8in. stroke, link-reversing motion, worm geared 90 to 1, drum 2ft. by 1ft. 6in. wide. A splendid lot.

R. H. LONGBOTHAM AND CO., LTD.,
Wakefield. 645 G

For Sale:—

STEAM-DRIVEN STRAIGHT-LINE AIR COMPRESSOR, by Holman; capacity about 1000 cub. ft. per min.; steam and air cylinders 18in. dia. by 2ft. 6in. stroke.
PAIR HAULING or WINDING ENGINES, 9in. dia. cyls. by 16in. stroke, two rope drums 5ft. dia., with clutch gear band brakes, &c. By Fowler and Co.
PAIR CROSS COMPOUND ENGINES, 600 H.P., 26in. h.p. cyl., 40in. l.p. cyl., 4ft. stroke, Corliss valves to h.p. cyl., slide valve to l.p. cyl., fly-wheel 20ft. dia., by Barclay, Sons and Co., Ltd.
CROSS COMPOUND HORIZONTAL ENGINE, 14in. h.p. cyl., 22½in. l.p. cyl., 32in. stroke, 12ft. dia. fly-wheel, by Davy, Paxman and Co.
350 K.W. ALTERNATOR, three-phase, 50 cycles, 550 volts, by B.T.H. Co., driven by 600 I.H.P. Cross-compound Engines by Barclay, 25in. H.P. cyl., 40in. L.P. cyl., 4ft. stroke, fly-wheel 20ft. diam., &c. &c. Very fine set.
One 200 K.W. SET, Engine by Bellias and Morcom; cyls. 9in. and 14in. × 12in. stroke; direct-coupled to Crompton's dynamo, 500 volts D.C., 380 r.p.m., 120 lb. steam.

R. H. LONGBOTHAM & CO., Ltd.,
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Tel. Add.: "Engineer, Wakefield." 2017 G

For Sale:—

45 RIVETED STEEL GIRDERS,
2ft. high, 9in. on flange, 26ft. 8in. long, two ribs in middle, 4in. plate top and bottom, ⅜ plate centre, three plates at bottom.
15 RIVETED STEEL GIRDERS,
22in. high, 9in. on flange, 25ft. 10in. long.
2 TANKS,
8 × 8 × 4.
2 CYLINDERS,
Steel, fitted with tubes, 12ft. 6in. × 3ft. 6in.
18 ROOF SPANS,
in new condition, 18in. high in centre, 3ft. 1in. ends, 27ft. long, made of two 6 × 3 channels, and braced by 3 × 2 steel angles.

All price £12 per ton, delivered free to works or f.o.r. London. Apply—
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FOR SALE,
Large Quantity YORKSHIRE and other GAS COKE.
THOS. DUXBURY and CO.,
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For Sale:—
Quantity good SECOND-HAND 18in. gauge
PORTABLE RAILWAY
complete with Two TURNTABLES and Three Sets POINTS and CROSSINGS to suit. 15 Set 24in. Gauge Points and Crossings, new C.I. Turntables, 24in. gauge. Sleepers, Crossing Timbers, and Pit Timber.

B. M. RENTON and CO.,
Market-place-buildings, High-street, Sheffield. Spl 3006

For Sale, Air Compressor, 1000 cub. ft. air per min.; two-stage, Vertical Compound Steam Engine, by Brotherhood; immediate delivery.—A. UNDERWOOD, 3, Queen-street, E.C. 674 G

For Sale, Battery of Three Wilson GAS PRODUCERS (Second-hand). Casing 10ft. diameter × 12ft. high, with platform 43ft. × 19ft., Hoppers, Pipes, &c. Two in use (one spare) have supplied gas to heat foundry stoves of 46,000 cubic feet capacity to about 580° F. Each producer has about 170 cubic feet capacity, and 28 square feet grate area, and the coal consumpt is about 7 cwts. per hour. Steam supplied by Cornish Boiler, 5ft. 6in. diam. × 18ft. long × 50 lb. pressure (Meldrum Furnace).—Apply, GLENFIELD and KENNEDY, Ltd., Kilmarnock. 655 G

For Sale, Blower, 5in., with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1705 G

For Sale, Capstan Winch, Pair 7in. cyls., 2 drums, by Joseph Evans.—A. UNDERWOOD, 3, Queen-street, E.C. 4. 676 G

For Sale, Cornish Boiler, 22 by 6, 90 lb. steam.
CORNISH BOILER, 24 by 5ft. 6in., 100 lb. steam.
CORNISH BOILER, 16 by 6, 100 lb. steam.
ECONOMIC BOILER, 16 by 9, 100 lb. steam.
LANCASHIRE BOILER, 24 by 7, for 120 lb. steam, no cross tubes, by Adamson.
All immediate delivery.
A. UNDERWOOD, 3, Queen-street, E.C. 4. 676 G

AUGUST.

Aeronautical Events.

AUGUST was a month of much rain and unseasonably strong wind. In consequence the aeronautical activity reported during its course was on a less intense scale than during its immediate forerunners. Nevertheless the degree of the work done was high, in so far as the Allies are concerned, and British, French and Italian aviators, in spite of the weather and the enemy, achieved noteworthy results. During the night of the 9th–10th British naval machines bombed Ghistelles aerodrome, Zuidwege railway sidings, and Thourout railway junction. The latter objective was also attacked by gun-fire from the air. On the afternoon of the 10th an attack was carried out by the same service against the aerodrome at Sparappelhoek. On the 16th, in the course of a series of raids, British naval machines dropped many tons of bombs on Ostend railway station and sidings, Thourout railway station and junction, and Ghistelles aerodrome. Attacks by gun-fire from the air were also carried out, the objectives being the aerodromes at Engel and Uytkerke and road transports. On the night of the 16th–17th the same service freely bombed the railway station and junction at Thourout. During the day of the 17th, and the night of the 17th–18th, French machines to the number of 111 took part in various bombing raids over the enemy lines. Altogether nearly 13 tons of bombs were dropped. Among the objectives were Colmar, Frescati, Hapsheim, and Freiburg-in-Breisgau. On the night of the 18th–19th the Naval Air Service continued its bombing operations against the enemy in Belgium. On this occasion Ghent, Thourout and Bruges were attacked, while on the morning of the 19th a further attack was made on the aerodrome at Snelleghem. During the return of our machines they were attacked by hostile aircraft, but these, with the help of a Royal Flying Corps patrol, were driven off, one enemy machine being shot down out of control. The enemy has also been active. At about 5.15 on the afternoon of the 12th a squadron of about 20 enemy aeroplanes dropped bombs on Southend, Margate and Rochford. Chief damage was done at the first-named town, where some 40 bombs fell. During the return of the raiders to the Belgian coast one of their number, a Gotha machine, was destroyed by a British naval pilot, and, in addition, a hostile seaplane was destroyed at about the same time off the coast of Flanders. The total casualities reported for the raid amounted to 32 killed and 43 injured. It was officially stated that the reports of our pilots clearly established the intention of the enemy to reach London, and that the action of our anti-aircraft guns had rendered our fighting squadrons great assistance in defeating his design.

Further Aeronautical Events.

WITH the opening of the Italian attack on the Austrians on the 19th an opportunity was afforded our Ally's aviators to take part in the infantry battle, and to help complete the work of which they had laid the foundations during the immediately preceding days. During the first day a total of 208 aeroplanes took part in the battle, and contributed materially to its success by using bombs and machine guns against the troops assembled in the rear of the enemy's lines. On the second day of the battle 261 aeroplanes took part in the work. Middelkerke and Bruges were bombed by our naval airmen on the night of August 19th–20th, and on the morning of the 21st a Zeppelin airship was shot down in flames by British light craft off the coast of Jutland. An air raid against the Yorkshire coast was carried out on the night of the 21st by several enemy airships. One only of these, or at most two, ventured inland. Twenty-five bombs were dropped, but only one person was injured. Next day, the 22nd, at about 10.15 a.m., ten enemy aeroplanes passed over Dover, Margate and Ramsgate. The bombs dropped resulted in 11 deaths and 13 cases of injury. Three of the raiders, all of the Gotha type, were destroyed by naval and military pilots, and by anti-aircraft gun-fire. The intercepting squadrons sent up from Dunkirk had an indecisive engagement with the actual raiders, but in a fight between 10 of the British machines and about 25 German escorting scouts, five of the latter were driven down completely out of control, while all our machines returned safely. On the morning of the 22nd Zeebrugge and Ghistelles were bombed by our naval airmen, and on the morning of the 23rd dumps at Middelkerke and Raversyde, and the Houttave aerodrome, were attacked. St. Denis Westrem aerodrome was bombed on the night of the 25th–26th. On this occasion one of our machines failed to return. The air fighting on the British front during the month was characterised by a period of great activity, preceded and succeeded by periods of comparative calm arising from the adverse weather. According to Sir Douglas Haig's reports we lost, as missing, 105 aeroplanes during the month. British aviators destroyed 135 enemy craft during the same time, while an additional 103 were driven down out of control. Three other German machines were accounted for by gun-fire from the ground. Three observation balloons were sent down in flames by our aviators, and four others were driven down out of control.

Naval Incidents.

VERY little indeed was reported from the sea during the past month. On the 14th the Admiralty announced that a British destroyer had struck a mine and sunk in the North Sea. Three officers and 43 men were saved from her. On the 16th British light naval forces scouting in the German bight sighted, fired upon, and chased an enemy destroyer. The German vessel was seen to be hit repeatedly and to be on fire, but she escaped through the mist over a mine-field. Soon afterwards some enemy mine sweepers were sighted and fired upon. At least two of these vessels were seen to be badly damaged, but they escaped in the same manner as the destroyer. The British vessels during the engagement were attacked by a submarine, and after the engagement by a second submarine, in both cases unsuccessfully. Our vessels suffered no damage whatever.

The Threatened Railway Strike.

THE first war bonus was granted to railwaymen in February, 1915, and in the following June was extended to the youths. In September of the same year the amount was increased, and on that occasion both the unions concerned agreed that they would not submit any further applications. Another advance was made in September, 1916, and a further one in April last. In July last another application was made, but on this occasion the two unions did not act together. The National Union of Railwaymen asked that the bonus should be converted into standing wages, and a further advance of 10s. per week be added, whilst the Associated Society of Locomotive Engineers and Firemen wanted an advance in wages, the establishment of an eight-hour day, payment at overtime rates for all night duty, and 14 days' holiday. It also sought the establishment of a sliding scale to regulate wages according to the cost of living. The National Union agreed, with the companies, on August 8th, to accept the war bonus as standing wages, a concession which has the result of increasing the amount of pay for overtime, Sunday duty and holidays, and, according to the President of the Board of Trade, will raise the burden of the bonus from £22,000,000 a year to £25,000,000. On the other hand, the Associated Society's demands could not be accepted by the Railway Executive Committee, and were referred to the Board of Trade. Sir Albert Stanley saw the delegates on more than one occasion, and explained that it was out of the question to deal with such an important subject at the height of the war, but he undertook that when the war was over the matter should be looked into. The men were not satisfied with this, and for some days there was a fear of a strike, but on Sir Albert Stanley, on the 21st, putting his views in writing, it was stated by the Society that the trouble was over. Since then there have been meetings between the Railway Executive Committee and representatives of the enginemen, but by the end of August no agreement had been arrived at, and in the last days of the month negotiations between the Associated Society and the Railway Executive were broken off.

Research.

THE report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1916–17 was published early last week, and with it the second annual report of the Advisory Council. The former is virtually a *résumé* of the latter, which is a long statement of the activities of the Council during the past twelve months. The Department for Research, an abbreviated title which, we suggest, may be conveniently employed to effect the fusion of different names which are a little bewildering, has, we are told, concluded negotiations for taking over from the Royal Society the property and responsibility of the National Physical Laboratory; that, in order to deal effectively and systematically with the urgent problem of fuel economy, it has appointed a Fuel Research Board, with Sir George Beilby as Director, and that this Board has appointed an Irish Committee to inquire into Peat as a Source of Power; that a Department of Technical Optics has been established at the Imperial College of Science, with a grant of £1000 per year for five years, and a special grant of £750 for apparatus, to which the College authorities are adding £2000; that recommendations in respect of aid of forty-four, of which thirty-five are new, scientific investigations of industrial importance have been approved; that instead of spending £6000 on individual students and research workers during the year it has seen its way only to expend £3550, and that, owing generally to the disturbance caused by the war, it has been able only to expend £14,524 out of the £40,000 put at its disposal by Parliament. From all of which it will be seen that, whilst the Department has not moved as rapidly as a good many people desired, yet it has made some progress, and the report of its Advisory Council shows abundantly that it is at least thinking hard, and that the preparatory steps in a number of many investigations, which cannot fail to be of service to the Empire, have already been taken. Further reference to its activities will be found in a leading article to-day, and we continue the reprinting of long extracts from the reports.

National Electric Supply Problems.

THE issue of the report of the Committee for the interconnection of the Lancashire and Cheshire electricity supply systems has directed fresh attention to the question of reorganising electric supply on national lines. The report in question is valuable, not so much for the light it throws on the advantages which would follow linking-up, as for the proposal to establish a Joint Board for this important industrial district to exercise full statutory powers with regard to all power stations and transmisson lines in the area of Lancashire and Cheshire. It is pointed out that the majority of the electricity undertakings, which include some of the largest and best equipped stations in the country, are owned and operated by the municipal authorities, and the prices charged for energy for industrial purposes compare favourably with the lowest charges made elsewhere. It is felt that the time has passed when powers to generate electrical energy should continue to be exercised solely for the purpose of supply within a municipal area which has nothing but an accidental relation to the industrial situation. The Committee considers it essential therefore that extensions of existing power stations or the provision of new power stations should only be proceeded with after due consideration has been given, not only to the requirements of the particular area in which the stations may be situated, but also of the actual or potential requirements of the surrounding districts, without regard to municipal or other boundaries. It is believed that the necessary control could without harm to existing interests be exercised by the proposed Joint Board, whose function it would be to ensure that future developments were co-ordinated along sound technical and commercial lines. It is suggested that large units of plant of from 10,000 kilowatts to 15,000 kilowatts should be concentrated in carefully selected localities and interconnected by a high-tension transmission system. All suitable sources of waste heat would be utilised. The opinion is expressed that by effecting these changes not only would there be a considerable reduction in the annual costs incidental to a lower capital expenditure per kilowatt of plant installed, but a great saving in fuel consumption as well as reductions in other working expenses. The inference to be derived from this report is that municipal interests, dissatisfied with inadequate representation on the National Committee, are working out the supply problem on a national basis for themselves. If this scheme is approved and the same policy is adopted by committees working in other areas, it is clear that a possible solution of the supply problem may have been reached while the National Committee of the Board of Trade is still considering ways and means.

Waterways Control.

EXPERIENCE of the working of inland waterways under Government control has indicated that a more effective use might probably be made of the British canal system by a process of decentralisation. It has therefore been decided to establish three separate sub-committees to control the waterways within particular areas, the headquarters of the district committees being in London, Leeds, and Birmingham. The London committee has control of the Grand Junction, Regent's Canal, Oxford Canal, and the Birmingham and Warwick and Napton Naviga-

tions. The Midland committee has taken over the Trent and Weaver Navigations, the Birmingham Canals, the Shropshire Union, Severn Navigation, Gloucester and Berkeley Ship Canal, and other connecting or subsidiary navigations. The most important waterways of which control has been assumed by the Leeds committee are the Aire and Calder, the Leeds and Liverpool and Bridgewater Canals, the Rochdale Canal, and the Sheffield and South Yorkshire Navigation. It is common knowledge that, in face of the fact of railway congestion having made it necessary to promote the use of inland waterways for transport to the greatest possible extent, the waterborne traffic has declined during the war period. This restricted use of the canal system arises from the fact that both the canal companies and the carriers on the canal have, owing to military demands, lost a considerable number of employees, with the result that many boats have had to be laid up. The Central Canal Control Committee, of which Sir Maurice Fitzmaurice is chairman, will handle the labour problem, and if the men are found to work the boats which have been out of commission it is hoped that the district committees, in co-operation with carriers and traders, will be able to make a greater use of the canals. The working of the new organisation will be watched with considerable interest, and if, owing to the congested traffic conditions, the present attempt to encourage a more extended use of the canal system is neither ruled out by economic or competitive considerations, the results may throw some light on the vexed question whether any such large expenditure on the improvement of inland waterways, as was suggested in the report of the Royal Commission on Canals, would be justified.

New Shipbuilding Yards.

IT is already recognised that, owing to the depletion of the world's tonnage, active conditions in the shipbuilding industry are ensured for a long period. The demands not only from British owners, but from foreign sources for new merchant ships, will throw a strain on the building capacity of home yards which they will be unable to meet unless these resources are expanded. Hence the many schemes now in process of inception for new shipbuilding establishments as well as extensions of existing yards. One of the new developments announced during the past month is the decision to re-open an old yard on the Mersey. The new company, to be known as the Mersey Shipbuilding Company, has acquired a site at Seacombe with the object of undertaking the construction of merchant ships and the smaller class of naval boats. A good number of well-known vessels were built in the old yard on the same site, including Lord Brassey's steam yacht the Sunbeam. On the Clyde, Harland and Wolff are contemplating an extension of the Caird yard at Greenock, in which they now hold a controlling interest, as well as an extension of fitting-out facilities. This project will necessitate the taking over of a portion of the old West Harbour at Greenock. Extensions are also being made at Port Glasgow by Russell and Co., and by A. and J. Inglis. On the East Coast of Scotland a new yard is to be put in operation at Leith by John Cran and Co., and it is understood that another new yard will be established at Kinghorn. New shipbuilding works are also being arranged for at Aberdeen. The most ambitious scheme to which publicity was given during August is that in which Sir John Ellerman is interested. The site selected for this yard is at Pallion, Sunderland, where an old yard of some 16 acres has been acquired on behalf of a new company. It is understood that it will be possible to provide four berths for the building of large ships, and that the intention is to lay out the yard on a scale which will find employment for some 3000 men. The situation is an excellent one, the launching facilities being good. On the Tees also developments are in prospect, and it was announced a few days ago, that Lord Furness had completed the purchase of eighty-five acres of reclaimed land on the north bank as a site for a shipbuilding yard, dry docks and engineering works. All these facts indicate that the country means to resume its position in shipbuilding as soon as circumstances permit.

Standard Ships.

THE trial trips of the first of the standardised ships built to the order of the British Government, which took place towards the end of the month, are stated to have given every satisfaction, and a large number of these useful cargo vessels should be in commission in the near future. Within a period of less than six months from the laying of the keel, this first vessel was ready to be put in service. Two types of standard ships each of 8000 tons deadweight carrying capacity are being constructed, one being a single deck ship and the other a two-deck ship. It is intended to construct two smaller types of 5000 tons and 3000 tons deadweight capacity respectively. Consideration is also being given to other types of standard vessels, and the Government programme in its entirety represents a very large output. It will be recalled that not only the hulls but the machinery and engines, including the auxiliaries, are also standardised, and the vessels are being constructed under the supervision of the three great classification societies, Lloyd's Register, British Corporation, and the Bureau Veritas. Special attention has been paid in the design adopted to the provision of large hatchways, making the ship almost self-trimming, while the equipment is such as to facilitate rapid loading and discharging. A feature of the ship which attracted much interest on the trial trip was the improved quarters, as compared with those of the ordinary cargo steamers, provided for the crew, which is berthed aft in the poop instead of in the forecastle, while the messing arrangements are entirely separated from the sleeping accommodation. The Shipping Controller has stated it is expected that similar vessels will in future be built in from four to four and a-half months, and that the programme undertaken in conjunction with what is being achieved in American yards, gives assurance that within a measurable period the shipping tonnage at the disposal of the Allies will continue to increase in spite of the losses from submarine activity. We may add here that two supplements to Lloyd's Register, just published, show that in six weeks, up to July 17th, over one hundred new vessels were added to the register, of which sixty-three are British and mostly of large tonnage. It should be pointed out that the standardisation of engines and machinery adopted for the Government programme is admittedly to some extent an emergency plan. What is being done to frame rules for a permanent system of standardisation of marine engines and auxiliaries is referred to elsewhere in this issue.

New Honours.

THE first lists of those whom the King has been pleased to honour by admission to the Order of the British Empire—an Order which takes position immediately after that of the Bath—were published on the 25th of the month, and contain many names of engineers and scientific men. To repeat them all here is both impossible and unnecessary, but we may mention a few men who have been specially identified with the profession and industries we represent. First let us record the name of Thomas Bell, managing director at Clydebank, and of George John Carter, who holds a similar position at Cammell Laird and Co.'s, Birkenhead. The excellent work done by Dugald Clerk is so widely known that one can only feel surprise that honours have not come to him sooner. Alfred Herbert has won his knighthood at the Ministry of Munitions, but he earned it long before by his work for the British machine-tool trade. Two men who have performed incalculable services for the war are Professor Herbert Jackson, whose brilliant investigations into glass saved the situation at a critical time, and Wilfrid Stokes, whose trench-mortar is a household word. We have expressed surprise that their names did not appear in earlier lists, and we are glad, indeed, that they have now received honours that for many generations to come will be remembered by their association with the great war. These and many others are Knights of the British Empire. Amongst the Commanders the names of engineers appear frequently. First in alphabetical position is Leonard Bairstow, chief of the Aerodynamics Department of the National Physical Laboratory; then William Bryant, of Brotherhoods, and William Blane, who has acted on several occasions as Special Commissioner for THE ENGINEER. Then Alan Chorlton, the expert on gas engines at Ruston, Proctors, and Henry Fowler, who was locomotive superintendent at Derby, before the war called him to other duties. F. W. Harbord is a familiar figure at all the meetings of the Iron and Steel Institute, and Andrew Laing, of the Wallsend Slipway and Engineering Company, is known by everyone in shipbuilding circles. There are many other names that might be mentioned—Sir William Collingwood, K.B.E., of the Vulcan Foundry, and Professor Ripper, who has been created a Companion of Honour, for example—and we do not omit them from lack of appreciation of their merits, but from want of space. We must mention in conclusion of this note that honours have been granted relatively as freely to Labour leaders as to engineers and scientists.

LOCOMOTIVE PERFORMANCE ON THE NORTH-EASTERN RAILWAY.

(By a Correspondent.)

No. I.

SINCE Sir Vincent L. Raven's appointment as Chief Mechanical Engineer, the new locomotives of the North-Eastern Railway have mostly been of the multi-cylinder type. At one time this company stood alone in its employment of two-cylinder compound engines; this was during the *régime* of the late Mr. F. W. Worsdell, who was Superintendent of the Locomotive Department from 1885 to 1890, being succeeded in the latter year by his brother, Mr. Wilson Worsdell, whose first express engines were of the usual 4–4–0 type, known officially as class M, having two cylinders, 19in. diameter by 26in. stroke. The coupled wheels are 7ft. 1in. diameter, and the total heating surface of boiler and fire-box is 1341 square feet, but one of the class—No. 1619—received exceptional treatment, being at first built as a two-cylinder compound. The stroke of both cylinders was 24in.; the high-pressure cylinder, placed on the left-hand side of the engine, had a diameter of 20in., and the low-pressure 28in.; both were fitted between the frames, the valve chests being outside; Stephenson link motion was employed, with the excentrics on the driving axle in between the cranks, a rocking shaft being utilised to transmit the motion to the outside valve chests.

In 1898 Mr. Worsdell rebuilt this engine as a three-cylinder compound on the system of the late Mr. W. M. Smith, who was works manager at Gateshead, and this engine was the prototype of the well-known three-cylinder compound express engines of the Midland Company. The high-pressure cylinder is placed between the frames, and has a diameter of 19in. with a 26in. stroke; the low-pressure cylinders are outside, 20in. diameter by 24in. stroke, all three being placed in line and driving on the same pair of wheels. As rebuilt, this engine had a boiler and fire-box provided with 1171 and 118½ square feet of heating surface respectively, giving a total of 1328½ square feet; this was later increased by some 34 square feet by the provision of water tubes in the fire-box. The grate area is 23 square feet, and the boiler was pressed to 200 lb. The engine weighed, in working order, 53 tons, with 35½ tons on the coupled wheels. No. 1619, however, remained the only three-cylinder engine on the system until Sir Vincent L. Raven took over the reins of office.

During 1896-7 Mr. Worsdell designed and built 32 more 4–4–0 express engines, known as class Q and Q1, the former class numbering 30, and having the same wheel diameters as the M class, but cylinders ½in. larger in diameter and a total heating surface of 1216 square feet, of which the fire-box supplied 127 square feet. The valves are on top of the cylinders, being actuated by rocking shafts, and a boiler pressure of 175 lb. is provided. The latter class consists of only two engines, which are remarkable, in that they possess the largest coupled wheels in this country, having a diameter of 7ft. 7½in.

These were followed in 1899 by a larger and handsome class of 4–4–0's, known as class R, which are among the most successful engines of this type in the country. They have two cylinders, 19in. diameter by 26in. stroke, Stephenson link motion, coupled wheels, 6ft. 10in. diameter, and bogie wheels 4ft. diameter. The heating surface totals 1527 square feet, made up of 1383 square feet in the tubes, and 144 square feet in the fire-box, which has a grate area of 20 square feet, and the boiler was pressed to 200 lb. The weight is 51¾ tons, of which 35¼ tons rest on the coupled wheels.

In the same year 4–6–0 engines were built, which are now generally employed on fast goods traffic, but can equally give a good account of themselves on express trains when necessary; in fact, they were originally intended for fast passenger work and were the first six-coupled express engines in this country. They have cylinders 20in. diameter by 26in. stroke, 1639 square feet of heating surface in the tubes, and 130 square feet in the fire-box, a total of 1769 square feet. The bogie wheels are 3ft. 7½in. diameter, and coupled wheels 6ft. 1½in.—five were constructed, with coupled wheels 7in. larger—and weigh 62 tons 8 cwt., the larger-wheeled batch weighing 67 tons 2 cwt., of which 46¼ and 51 tons 19 cwt. is available for adhesion respectively. Sir Vincent has increased the class to a total of 65 engines, with superheaters among other improvements, while one is experimentally fitted with Stumpf cylinders.

In 1903 Mr. Worsdell, after a visit to America, constructed ten "Atlantics," having cylinders 20in. diameter by 28in. stroke; coupled wheels, 6ft. 10in. diameter; bogie wheels, 3ft. 7½in., and trailing wheels, 4ft. A boiler 5ft. 6in. diameter is fitted, supplying 2456 square feet of heating surface, divided between 2276 square feet in the tubes, and 180 square feet in the fire-box. The grate area is 27 square feet, and the working pressure 200 lb. These engines have 39 tons available for adhesion, out of a total weight of 72 tons. A further set of ten was constructed in 1910; they have cylinders ½in. smaller in diameter and heavier frames, thereby increasing the weight to 76 tons 4 cwt., of which 40½ tons are utilised for adhesion; but before the construction of these later engines, Mr. Worsdell built in 1906 two four-cylinder compound "Atlantics"

on another system, invented by the late Mr. W. M. Smith. These engines received the numbers 730 and 731, and in this instance the low-pressure cylinders, which are fitted between the frames, have a diameter of 22in., while the high-pressure cylinders outside the frames are 14½in. diameter, the stroke of all cylinders being 26in. The boilers were pressed at 225 lb., and had a total heating surface of 1962 square feet; the grate area being 29 square feet. The bogie and trailing wheels are similar in diameter to the other "Atlantics," but the coupled wheels are 7ft. 1½in. diameter. No. 730 was fitted with a modification of the Stephenson link motion, and No. 731 with a modification of Walschaerts' gear, one set of valve gear actuating the distributing valves for one high and one low-pressure cylinder.

Mr. Worsdell's final design of express engine was a very handsome 4–4–0, having the same size cylinders and coupled wheels as class R, of which it is virtually an enlargement, being classed R1, but a larger boiler is employed, having a total heating surface of 1737 square feet, 158 being in the fire-box, which has a grate area of 27 square feet. The weight, in working order, is 59½ tons, 42 tons being distributed on the coupled wheels, while in this instance a working pressure of 225 lb. is used.

Mr. Worsdell retired in May, 1910, and Sir Vincent L. Raven's first design was a 4–6–2 tank engine for mineral service, which he provided with three cylinders, each having a diameter of 16½in. with a 26in. stroke, to drive coupled wheels, 4ft. 7½in. diameter, the bogie and trailing wheels being 3ft. 1½in. and 3ft. 9½in. respectively. The total heating surface is 1648 square feet, and the working pressure 180 lb. They weigh 87 tons, with 55 tons 12 cwt. for adhesion, and are capable of hauling 1000 tons on the level at 20 miles an hour.

These engines were followed by 20 "Atlantics," having the same cylinder arrangement, but, owing to the works at Darlington being fully occupied with other work, they were constructed by the North British Locomotive Company, Limited, of Glasgow; half were "wet steamers" and half were fitted with Schmidt superheaters, but so successful were the "dry steamers," that all are now fitted with superheaters, and most of the other express engines are being so fitted when they require heavy repairs. The boilers are 5ft. 6in. diameter and 15ft. 10½in. long, the tubes providing 1295.8 square feet of heating surface, the fire-box has 180 square feet, and the superheater tubes 530.1 square feet, making a total of 2005.9 square feet, the grate area being 27 square feet. The cylinders are placed in line, and have the same dimensions as the mineral engines mentioned above. They are cast in one with the piston valve chests, the exhaust from all three cylinders being brought into one central blast pipe. The wheel diameters are the same as of Mr. Worsdell's "Atlantics," but the working pressure is only 160 lb., and the engines weigh 77 tons 2 cwt., with 39 tons 17 cwt. on the coupled wheels. The number of these capable and economical machines now totals more than sixty, and most of them are now fitted with an ingenious regulator, designed by Mr. Norman Lockyer, who is works manager at Darlington.

Mention should be made of the three-cylinder superheater 4–4–4 tank engines, of which thirty now exist, having similar cylinders to the "Atlantics," and a boiler and fire-box giving a total heating surface of 1331.9 square feet. They weigh 84¼ tons, with 39 tons 14 cwt. on the coupled wheels, which are 5ft. 9in. diameter. These engines have proved very successful on some of the more steeply graded branches.

Turning now to gradients, the main line from York to the North is by no means easy, though probably the greatest obstacle to fast running resides in the several speed restrictions necessitated by coal subsidences and other causes at Darlington, Croxdale, Durham, Ouston Junction, approaching Newcastle, Morpeth, Tweedmouth, and Berwick.

The first section to Darlington, a distance of 44¼ miles, is certainly easy, although it is mostly "collar" work for down trains, with an average rise of but 2ft. per mile. From Darlington is a rise of 1 in 462 for a mile, followed by 1½ mile at 1 in 200; then come 7 miles at easier grades or level, after which are 2 miles uphill at 1 in 203, followed by a fall at 1 in 528 for the same distance. From Ferryhill the line rises easily for 1¾ miles, succeeded by a 3 miles fall, beginning at 1 in 200, and finishing with 1 in 150 near Croxdale, followed by a like ascent of more than a mile; the speed restriction above-mentioned intervening makes difficult work for heavy trains in either direction. Now comes a steep fall at 1 in 101 and 120 to Durham, but, here again, no advantage can be taken owing to the enforced service slack at Durham viaduct, while for up trains this stretch is distinctly difficult. The next 11 miles are generally falling, nearly a third of the distance at 1 in 150, and the final section to Newcastle is rising or level, the steepest grade being 1 in 198, but as this last section includes a slack for Ouston Junction, and the slow approach over King Edward Bridge, across the Tyne, it will be realised that for a heavy express train the journey from York is a difficult one, as the delays must represent a loss of more than five minutes.

With regard to the performances recorded, all loads are reckoned behind the tender, and no allowance is made for the above-mentioned compulsory speed restrictions.

First, No. 718, a three-cylinder "Atlantic," with 325 tons, passed Alne, 11¼ miles, in 15 min. 16 sec., and Otterington, 26½ miles, in 30¼ min., and was travelling at 65 miles an hour on the rise at 1 in 628, which extends to Northallerton, when a bad signal check was encountered. Recovering from this, 70.3 miles an hour was attained on the fall at 1 in 377 near Croft Spa, and Darlington was passed at reduced speed in 48 min. 35 sec., of which 1¼ minute should be deducted for the signal delay. The next 12¾ miles, mostly uphill, required 13 min. 56 sec., and Durham, 66¼ miles, was passed at ten miles an hour, in 72 min. 57 sec., despite the Croxdale slack. On the following descent a maximum speed of 76.2 miles an hour was reached near Plawsworth, and after carefully observing the regulation slack at Ouston Junction, the train came to a stand for signals on the King Edward Bridge for 1 min. 43 sec.; finally stopping in Newcastle Central Station in 94 min. 23 sec., the net time being 89 minutes for the 80¼ miles.

With a load of nearly 390 tons, No. 2164, a similar engine, passed Alne in 15 min. 54 sec., and Northallerton, 30 miles, in 34 min. 27 sec., the maximum speed having been 65 miles an hour, and 36 miles were covered in 40 min. 20 sec., after which a succession of signal delays was encountered, but for which it was evident Darlington could have been reached in 48½ minutes, instead of the 53¼ minutes actually required.

One of Mr. Worsdell's Class R engines, No. 2016, fitted with a superheater, passed Alne in 15 min. 55 sec., although the load totalled 385 tons. Northallerton was passed in 35 min. 21 sec., and the maximum on the slight descent of 1 in 2444 through Danby Wiske was 634 miles an hour. Darlington was cleared in 49 min. 27 sec., and Ferryhill, 57 miles, in 63 min. 47 sec. The speed reductions at Croxdale and Durham were faithfully, as always, observed, the latter station being breasted in 74 min. 53 sec. No higher speed than 68.2 miles an hour was recorded on the descent through Plawsworth, and, in addition to the usual speed reduction at Ouston Junction, two slight signal checks were experienced at Low Fell, and approaching Newcastle; nevertheless, we came to a stand in the Central Station in 93 min. 10 sec., 92 minutes net time; this was manifestly an excellent performance for a comparatively small engine. I have, however, noted similar times with Sir Vincent Raven's three-cylinder engines with loads totalling as much as 440 tons.

In the reverse direction, No. 2204, a three-cylinder "Atlantic," or class Z engine, with 370 tons, passed Dalton, 5¼ miles from Darlington, in 8 min. 6 sec., and Northallerton, 14¼ miles, in 17 min. 9 sec. Thirsk, 22 miles, was cleared at 62.5 miles an hour, in 24 min. 39 sec., and Sessay, 26¼ miles, at 68.2 miles an hour, in 28 min. 46 sec. The speed then gradually decreased until approaching the 5th mile-post, when it rose, for a short distance, to 65 miles an hour, and we stopped at York in exactly 47 minutes for the 44¼ miles, representing an average speed of 56½ miles an hour.

A sister engine, No. 2197, with 330 tons, ran this section in 44 min. 57 sec. In this instance, the times at the start were almost identical, but at Northallerton—passed in 16 min. 51 sec.—the rate of progression became faster, and on the slight descent of 1 in 628 and 624, which extends for 6 miles, the speed reached 70.3 miles an hour, and Thirsk was cleared in 23 min. 49 sec. For the next 9 miles a rate of 67.2 miles an hour was maintained, increasing again to 70.3 miles an hour in a further 4 miles, which proved to be the maximum, and then gradually receded to 65.2 miles an hour at the 4th mile-post, where steam was shut off, and we stopped at York as stated. These two performances may be taken as typical runs of the three-cylinder engines with heavy loads.

The performances of Mr. Worsdell's class R engines, when in charge of capable drivers, are frequently very fine. The best I have noted was with a train loaded to 380 tons, with which Chester-le-Street, 8½ miles, was passed in 12 min. 16 sec. from Newcastle, and the Plawsworth bank was ascended at a minimum of 35.7 miles an hour; Durham, 14 miles, was passed in 20 min. 25 sec., and Bradbury, 26 miles, in 35 min. 50 sec., the minimum after Croxdale having been 47.4 miles an hour. On the slight descent to Darlington a maximum of 69.2 miles an hour was recorded, and we stopped at that station in exactly 46 minutes for the 36 miles.

Re-starting, 53.6 miles an hour was attained on the rise of 1 in 356 to Eryholme, while on the slight rise of 1 in 2444 beyond Danby Wiske the rate reached 63.4 miles an hour, but the act of picking up water reduced this to 59.2 miles an hour. Northallerton was cleared in 16¾ minutes, remarkably fine work with such a load, and Thirsk in 24 min. 3 sec. The speed was well maintained thence to the 3rd mile-post, a distance of 20 miles being covered in 18 min. 19 sec., with no higher rate than 67.2 miles an hour, and 41¼ miles from the start had been reeled off in 41 min. 37 sec., when adverse signals intervened, so that the total time to the stop at York was 47 min. 39 sec., but the net time was only 45½ minutes, representing an average speed of 58.3 miles an hour.

No mention of North-Eastern locomotive work would be complete without reference to the trains which, for many years until the close of 1916, was booked to leave Darlington at 1.9 p.m., and arrive at York at 1.52 p.m., a schedule of 43 minutes, or an average speed of 61·7 miles an hour, and had the distinction of being the fastest start to stop booking in the British Empire. Many fine performances with this train by all the various types of express engines have been recorded, the journey having frequently been performed in 40 minutes. The last occasion on which the writer travelled by this train was in November, 1916, when the engine, No. 2164, a three-cylinder "Atlantic," had the respectable load of 225 tons. We had not proceeded two miles when a vexatious signal check was encountered owing to a goods train mishap, which reduced our speed to a walking pace; however, recovering from this, we attained 52.9 miles an hour on the rise of 1 in 356, which gradually increased to 70.3 miles an hour on a short upward grade of 1 in 1148, Northallerton being passed in 17 min. 26 sec., the delay having accounted for two minutes. On the slight descent of 1 in 628 which follows, a rate of 73.7 miles an hour was attained, and then maintained for a distance of 7 miles, receding in the next 4½ miles to 69.2 miles an hour. In the next mile and a-half the rate had again become 73.7, which, except for two occasions, when it fell temporarily to 72.5 miles an hour, was maintained for a further 7 miles. The remaining 8 miles to the stop, including another check, fortunately slight, were covered in 8 min. 18 sec., thus the total journey required 43 min. 59 sec. The 36 miles from mile-post 38 to mile-post 2 were reeled off in 30 min. 34 sec., and the 20 miles from mile-post 28 to mile-post 80 in 16 min. 32 sec., while the final 39 miles to the stop were covered in 34 min. 55 sec. The net time for the whole journey was 41¾ minutes.

OBITUARY.

HENRY RITCHIE.

WE place on record, with regret, the death of Mr. Henry Ritchie, principal and founder of the Clyde shipbuilding firm of Ritchie, Graham and Milne, Whiteinch, which took place on August 24th at Ayr. Mr. Ritchie was in his fifty-ninth year. He was born at Langbank on the Clyde, served his apprenticeship to marine engineering with the shipbuilding and engineering firm of Lobnitz and Co., Renfrew, and was subsequently employed in the works of various well-known Glasgow firms. In 1884 he went to India, but impressed with the great field which lay before home shipbuilders in the construction of steamers of light draught for shipment and re-erection abroad, Mr. Ritchie returned to Glasgow in 1887, and shortly thereafter identified himself with such work as carried on by Alley and MacLellan, Limited, Polmadie. Joining with Mr. John Graham and Mr. William Milne, who were foremen with that firm, he founded the firm of Ritchie, Graham and Milne in 1891, and started work in that year in Craigton-road, Govan. Some of the first contracts undertaken were for cargo flats for the East Indian Railway, and for launches and tugs, the engines for which were made by Ross and Duncan, Govan. The growing demands for vessels fitted with engines for steaming to their destination compelled the firm to look out for a yard having river frontage for launching its productions. For a time it occupied a small yard near Govan Ferry, and launched several vessels for the Amazon and other river service, and in 1895 entered into occupancy of the present premises at Whiteinch. On Mr. Ritchie devolved mostly the securing of contracts and the supervision of work, both in respect of its technical and commercial aspects. He was well supported in the conduct and supervision of practical operations by his partners, Mr. Graham and Mr. Milne, and in commercial matters from the very outstart by his brother, Mr. William Ritchie, who was assumed a partner after the retirement of Messrs. Graham and Milne four years ago. Three of Mr. Ritchie's sons have received a training in shipbuilding and marine engineering and are prospective partners in the business.

TELEPHONE ENGINEERING PROGRESS.

The recent improvements in telephone engineering in the United States have made intra-continental and trans-continental telephone transmission of speech a commercial actuality. These improvements in lines and equipment have greatly increased the range of telephone service. They apply largely to trunk line construction and to intermediate and auxiliary apparatus. To illustrate the value of such service for military purposes, the Navy Department for a period of three days abandoned all forms of communication between the department and the various naval stations and dockyards except the telephone and telegraph. In connection with mobilisation, instantaneous communication was obtained with all the various points. An interesting test was made also of wireless telephony, messages being sent by telephone to the wireless stations and there transferred automatically. Incoming messages were also automatically transferred from the wireless stations to the wire connections for the Navy Department. In one case the commander at the Mare Island dockyard, on the Pacific Coast, conversed with the captain of the New Hampshire, which was then in a storm on the Atlantic. This was by means of the trans-continental line to a wireless station near the Atlantic Coast. Much has been done in improving the efficiency of the long-distance lines. The extending adoption of electric traction by railways, and the rapid extension of electric power lines, introduce troubles in telephone operation in the neighbourhood of these circuits, and investigation is being made as to the rules governing the operation of such lines. Another important matter is the development of apparatus to be used by power companies to lessen their disturbance of telephone circuits.

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. V.*

WE have now reached a distinct turning point in the history of the chain track, so far, at any rate, as this country is concerned. The new epoch started with the investigations carried out by the War-office authorities in connection with mechanical transport.

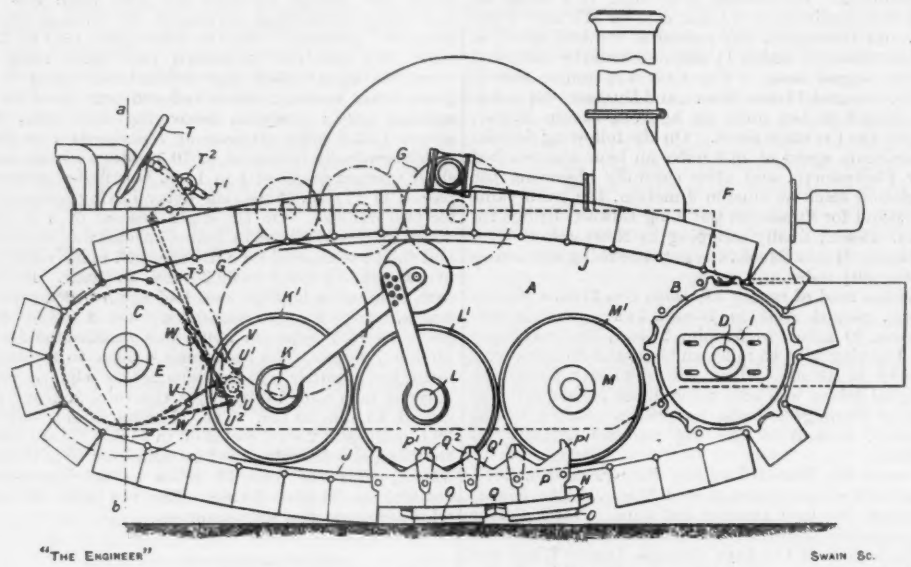

Fig. 41—THE ORIGINAL ROBERTS CHAIN-TRACK TRACTOR, 1904

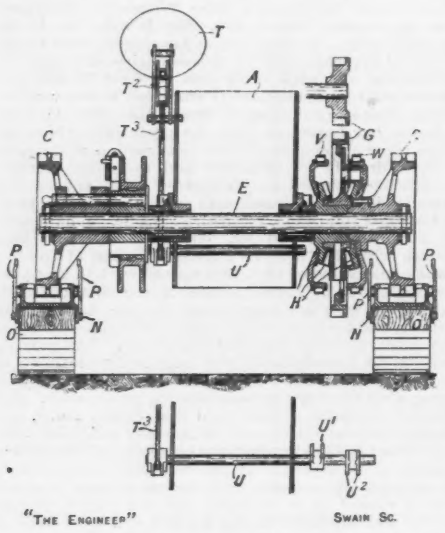

Fig. 42—THE ROBERTS CATERPILLAR TRACTOR, 1904

The trials, which were held with various designs of tractors, speedily demonstrated that ordinary road wheels were quite unsuitable for use on soft or irregular ground, and that machines fitted with them were quite incapable of surmounting the difficulties which had to be overcome in order to meet military requirements.

One of the most prominent among those who were at this period endeavouring to find the solution to the manifold problems which arose in connection with the design and construction of military tractors, was Mr. David Roberts, of the firm of Richard Hornsby and Sons, Limited, of Grantham. Mr. Roberts not only designed and patented, but constructed several tractors which were remarkably successful, and it was the first machine of his make which was tested at Aldershot that gained for this type of tractor the name of "caterpillar," as we shall show later.

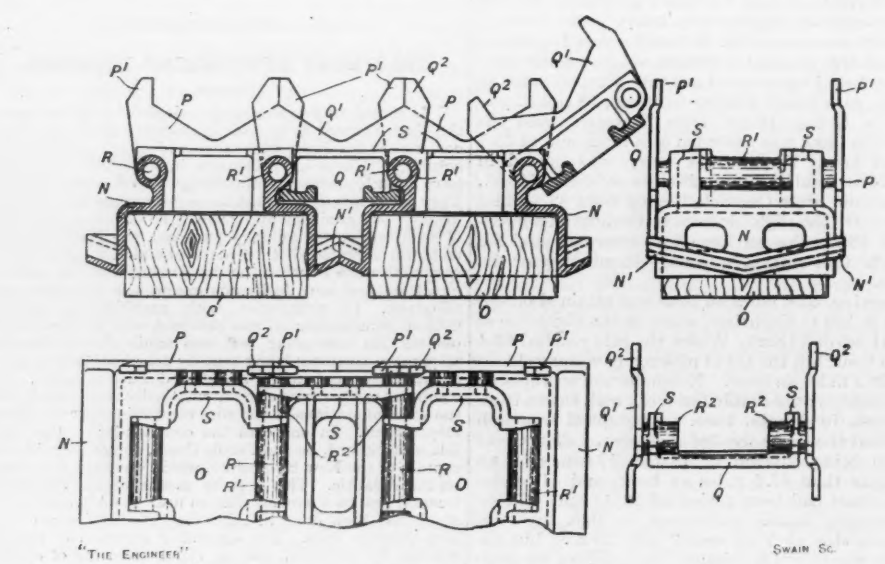

Fig. 43—ROBERTS' CHAIN-TRACK, 1904

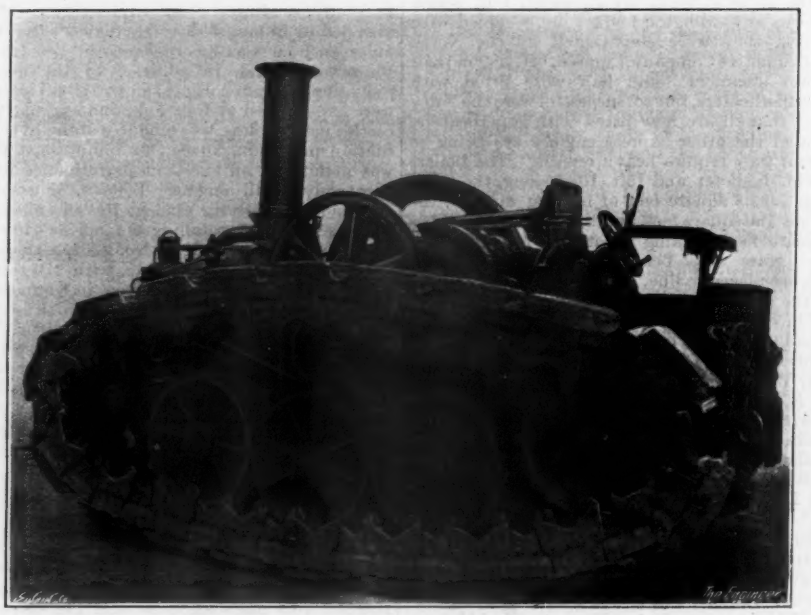

Fig. 44—THE ROBERTS CHAIN-TRACK TRACTOR, 1905

The first Roberts' chain-track tractor is shown in the engraving, Figs. 41 and 42, the first of which is a side elevation of the vehicle, and the second a vertical section through the line *a-b* in Fig. 41. In these drawings the body of the traction engine is shown at A. Mounted upon shafts D and E at the front and rear respectively are two sprocket wheels B and C. The propelling engine is shown at F, and it drives the rear shaft E through toothed gearing G and a differential H—see Fig. 42. Each of the bearings of the front shaft D is made adjustable, so as to enable the slack of the two chains J, which pass round the two pairs of sprocket wheels on the two sides of the vehicle, to be taken up if required. Three shafts, K, L and M, carry rollers K^1, L^1, and M^1—which themselves work on roller bearings. The rollers are all of the same diameter, and the centre shaft L is arranged to come slightly lower than the shafts K and M, so that the three rollers form a curved bearing surface on each side of the engine. They are designed to run upon the inner surface of the two chains J, and by them the weight of the vehicle is transmitted to the latter and through the chains to the ground.

What Mr. Roberts calls "a suitable construction of chain track" is shown in Fig. 43. It is formed of a number of links, each comprising a casting N, made with a pocket shaped to receive a renewable wood block O, and with a pair of side cheeks, P P. Intermediate links Q Q are used for connecting together adjacent castings N. They also are made with side cheeks Q^1 Q^1, and they are connected to the castings N by means of pins R R which pass through tubular lugs or bearings R^1 R^2 formed upon the castings and links respectively. The side cheeks P and Q^1 overlap one another, and each is formed with a pair of extensions or lugs P^1 Q^2 respectively, which are adapted to interlock with one another, as shown in the left-hand top drawing in Fig. 43. The adjacent castings N also abut against one another at their lower parts along the inclined surfaces N^1, and when the chain is subject to stress by reason of the weight of the vehicle, these two abutments form what may be regarded as the upper and lower members of a girder, so that the hinge pins R have only to take the stresses due to the propulsion of the vehicle. Each of the castings N and links Q is provided with tracks S, upon which the rollers K^1, L^1 and M^1 bear and roll when the chains are driven.

One of the features of the invention is the method in which steering is effected, it being accomplished by varying the speeds of the driving sprocket wheels on either side of the vehicle. The steering wheel T oscillates the spindle U through the medium of the screw T^1, the lever T^2, and the coupling rod T^3. The spindle has attached to it two levers, U^1 and U^2, which operate band brakes which bear respectively upon the peripheries of the bevel wheels V and W of the differential gear mechanism H. With this arrangement, by revolving the hand wheel in one direction the brake is applied to, and retards the motion of, one of the bevel wheels of the differential gear, and by turning the hand wheel in the opposite direction the motion of the other bevel wheel of the gear is retarded. In this way one or other of the chains J is made to go faster than its companion, with the result that the vehicle can be steered. Mr. Roberts did not confine himself to this arrangement, but explained that the brake might be applied directly to the sprocket wheels, or one brake to one of the sprocket wheels, and one to the rear shaft.

It should be explained that the weight of the upper

* No. IV. appeared August 31st.

part of the chains J, where they come between the sprocket wheels B and C, is taken by means of a wheel. This wheel is carried in bearings at one end of a connecting-rod, the other end of which has its bearing on the shaft K, and its height is varied by pins passed through it, and through the various holes shown in the connecting-rod, which has its bearing on the shaft L.

The first machine of this type was constructed by applying the mechanism we have described to an oil traction engine, and three views of it are shown in Figs. 44, 45, and 46. It formed the subject of patent

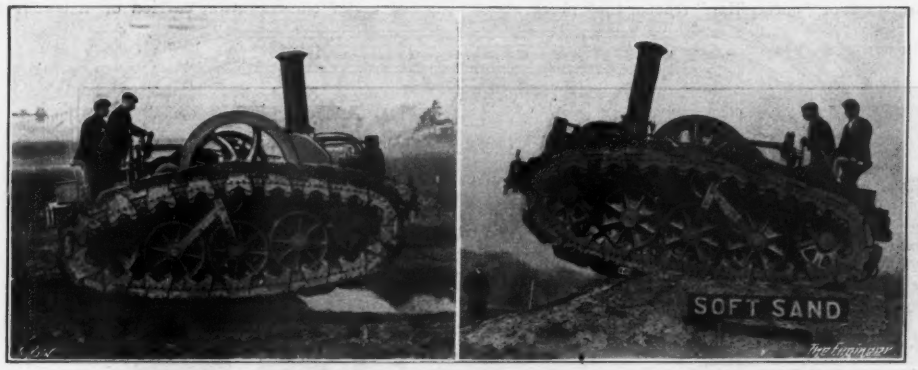

Fig. 45 and 46—THE ROBERTS TRACTOR ON TRIAL, 1905

"Improvements in portable or self-laid tracks for road locomotives and other road vehicles." It was particularly concerned with improvements in the construction with the pitched chain track, with the object of rendering it more durable and simple, as well as more silent in running and capable of having worn parts renewed with greater facility than had up to then been possible.

The improved track was made with a chain, comprising alternate inside and outside links, preferably made of malleable iron or cast steel, hinged to one another at or near the upper edge by means of hinges

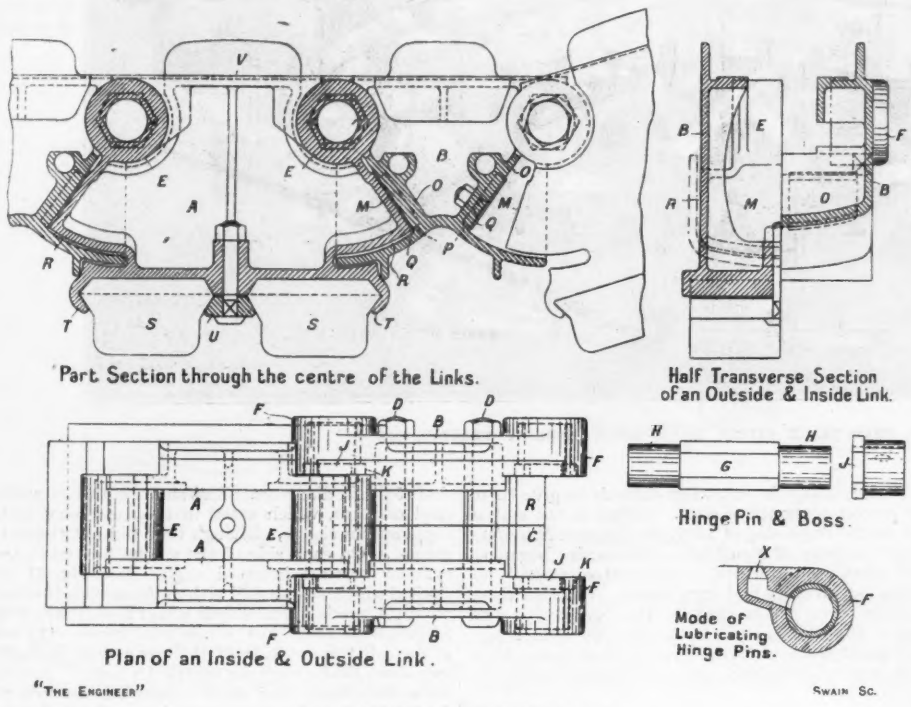
Part Section through the centre of the Links.
Half Transverse Section of an Outside & Inside Link.
Plan of an Inside & Outside Link.
Hinge Pin & Boss.
Mode of Lubricating Hinge Pins.
"THE ENGINEER"
SWAIN SC.

Fig. 47—ROBERTS' CHAIN-TRACK, 1906

No. 16,345 of 1904, was made by Richard Hornsby and Sons, and was shown to individual members of the Mechanical Transport Committee of the War-office at various dates from July, 1905, onwards. A final demonstration of its working took place at Grantham, in February, 1906, at which practically the whole of the Mechanical Transport Committee and some other War-office officials were present.

Following up the subject, Mr. Roberts, in 1906, took out another patent, No. 3448 of that year, for resembling door hinges. Each of the inside links was cast in one piece, whilst each of the outside links was divided longitudinally into two parts, which were secured together by bolting. To hinge the links together each of the inside links was made at each end with a central bore, having a square, rectangular, hexagonal, or other polygonal hole, and each of the outside links was formed with a pair of bosses at each end, which were brought into alignment with the central boss upon the inside link. These latter bosses were also formed with square or polygonal holes for receiving similarly shaped flanges upon bushes adapted to be inserted in them. The links were jointed by means of pins, which were passed through holes in the bushes, these pins being square or polygonal at the central portion where they engaged the bosses upon the inside links, and cylindrical at the two ends, where they engaged in the bushes. The hinge pins together formed, Mr. Roberts explains, the upper member of a girder, while the adjacent faces or ends of the inside and outside links together formed the lower member of the girder.

The arrangement will be readily understood by the aid of the drawings given in Fig. 47. In this A A are the inside links, which, as already pointed out, are made in one piece, and B B are the outside links, which are divided longitudinally into two parts on the line C, and are held together by the bolts D. A central boss E is formed at each end of each inside link, and it has a central hole, which is square or polygonal in form. The bosses F, on the outside links, which are also square or polygonal in shape, are intended, when the links are built up, to be brought into alignment with the bosses E on the inside links. One of the hinge pins is shown on the drawing. As will be observed, its central part is of the same polygonal shape as are the holes in the bosses E and F, and that its ends are cylindrical, so as to fit into bushes, one of which is shown beside the pin, and which are formed with polygonal flanges J, adapted to fit into similarly shaped recesses K in the bosses F. These pins constitute the upper member of a girder, and the faces M of the inside links and the faces O of the outside links constitute the lower members of the girder. The faces O are formed with recesses P, which are filled in with resilient or elastic pads Q to reduce the shock of impact on the closing of the links. Pockets or shields R are formed on the outside links B, and in them the faces M of the inside link A work so that they may be protected from the injurious action of grit or dirt. Treads S of wood or other suitable material, are fixed to the inside links A by means of lips T and clips U, and the curved paths on which the wheels or rollers supporting the vehicle roll are indicated by the letter V.

The teeth of the driving sprocket wheels engage with the external surfaces of the bosses E, and the ends H of the hinge pins are lubricated through cone-shaped recesses X, formed in the bosses and bushes of the outer links—see the drawing in the right-hand bottom corner of Fig. 47.

In his patent, No. 19,574 of 1907, Mr. Roberts, with whom was associated Mr. Charles James, also of the Hornsby firm, sought to improve the means of steering his tractors. It will be remembered that in his original patent steering was effected by means of applying a brake to one side or other of the differential by means of a hand wheel. This was found in practice not to be sufficiently quick or powerful in action for heavy traction engines and motor vehicles when running on difficult ground. In the 1907 patent an arrangement is shown by which the brake band was tightened by a pneumatic cylinder, which was operated by compressed air contained in a holder and fed by a compressor worked by the propelling engine. It will not be necessary to describe this particular invention at greater length.

As a result of the trials of the first Roberts' tractor, the War-office requested Messrs. Hornsby to fit chain tracks to a 70 horse-power Hornsby tractor, which had previously been purchased by that department, in order that experimental work could be continued. This order was given in August, 1906, and in the same month the firm purchased a 40 horse-power Rochet-Schneider car, and fitted to it chain tracks of a much lighter description than had been employed in the original engine. The official trials of the converted War-office tractor—a view of which is shown in Fig. 49—took place in July, 1907. We may here say that as soon as the Tommies at Aldershot, where the trials were held, saw the machine, they immediately named it the "caterpillar." That name has struck

Fig. 48—ROCHET-SCHNEIDER CAR FITTED WITH ROBERTS' CHAIN TRACK, 1907

to it in this country, and has, moreover, been adopted on the other side of the Atlantic. In the view shown in Fig. 49, it will be seen that Mr. Roberts had made sundry modifications as compared with the original tractor. The chains, for example, were made in

accordance with the patent of 1906. Another difference was that there were only two pairs of bearing wheels instead of three. In November of the same year—1907—the first trials of the converted Rochet-Schneider car were held also at Aldershot. This car is shown performing various evolutions in the three engravings given in Fig. 48. Both of these machines were exhibited and took part in the Royal Review at Aldershot, in May, 1908, and were then inspected by the late King Edward, and a few days later by King George, then Prince of Wales.

It was, we gather, during the period of the trials at Aldershot in 1908 that the first proposal was made that a special tractor constructed on these lines should be designed, so as itself to be a fighting machine instead of merely a traction engine. The suggestion was that it should be fitted with bullet proof shields, having a gun as an integral part of the tractor, or, as an alternative, that the gun should be carried on a chain-track carriage as a trailer. We believe we are right in attributing these suggestions to the then Major Donoghue, of the Mechanical Transport Committee. No action was, however, immediately taken to carry them into effect.

As a result of the experience obtained with these tractors, the War-office, in July, 1909, placed an order with Messrs. Hornsby for a light 60 brake horse-power chain-track tractor designed to fill certain military requirements, among which was the hauling of guns. The official trials of this machine, which is illustrated in Figs. 56, 57, 58, and 59, on page 208, took place in May, 1910, and consisted of long endurance road tests, and also trials in the Long Valley at Aldershot. Subsequently, we understand, the tractor was employed in a camp in North Wales, and later still on Salisbury Plain. It was exhibited by the War-office at Olympia in the early part of the summer of 1914.

A good many events bearing on the history of the chain-track or "caterpillar" tractor took place about this period, and it is somewhat difficult to give them their correct sequence of date. Either at the end of 1906, or the beginning of 1907, the Phœnix Manufacturing Company of Eau Claire, Wisconsin, began to build what were termed "locomotive sleds," for hauling logs over ice and snow roads. Whether these machines were constructed to the company's own designs, or to those of someone else, we cannot say. We illustrated and described one of these locomotives in our issue of July 26th, 1907, and we are enabled by the courtesy of the editor of the *Railway Gazette* to supplement the particulars of their construction, which we then gave by making extracts from an article which appeared in the issue of that journal for February 28th, 1908. Our own article was illustrated by the engravings which we reproduce in Figs. 50 and 51, while the article in our contemporary was accompanied by two engravings, showing the locomotive engaged in hauling heavy lines of sledges loaded with logs.

Generally speaking, the engines followed ordinary locomotive lines, but the boiler was mounted on a heavy channel iron frame, the channels being reinforced and extending from the extreme front end of the engine to the rear, so as to support the cab and the coal bunker. This frame rested on heavy traction wheels in the rear and on a sled in front. That part of the weight of the engine which, in an ordinary locomotive, would be carried by the drivers, was in the engines under consideration carried on a transverse

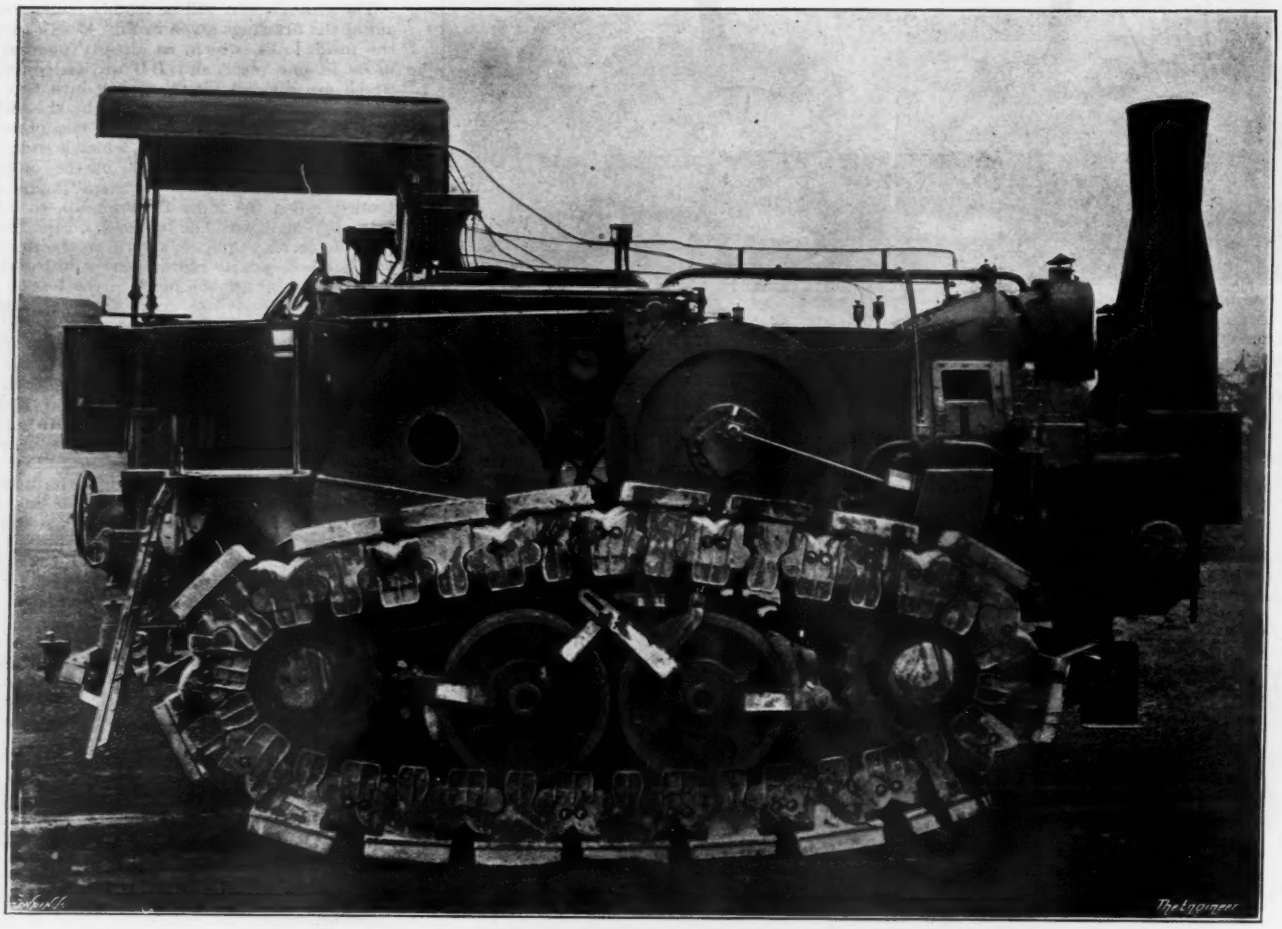

Fig. 49—ROBERTS' CHAIN-TRACK FITTED TO A 70-H.P. HORNSBY TRACTOR, 1907

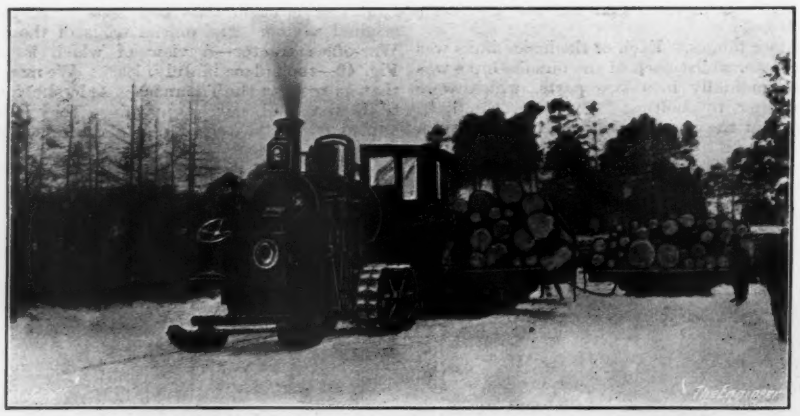

Fig. 50—THE PHOENIX COMPANY'S LOG-HAULING TRACTOR, 1906-07

shaft 5½in. in diameter. This shaft, in turn, rested on steel castings, which acted in the same way as the runners of a sledge, although they did not touch the ground. On each side of the smoke box was a two-cylinder vertical inverted engine—see Fig. 51—the shaft of which was parallel with the frames, and carried a pinion A gearing with a spur wheel B on the end of a longitudinal shaft just inside the frame. On each of the side frames, in front of the cab, were journalled two short shafts carrying sprocket wheels. A transverse 6in. fixed steel shaft connected the two side frames, and had near each end a quill, or sleeve, C carrying a bevel wheel and a spur wheel. The sleeve,

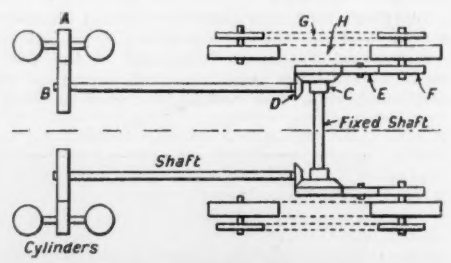

Fig. 51—DRIVING ARRANGEMENTS OF PHOENIX COMPANY'S TRACTOR

bevel wheel, and spur wheel formed a single casting. Each of the two longitudinal shafts driven by the engines had at its rear end a bevel wheel D which geared with that on one of the sleeves, while the spur wheel on the sleeve geared with an intermediate wheel E, which drove a gear wheel F, keyed to the rear sprocket shaft. A transmission driving chain G connected the sprockets on the two shafts. Besides the driving sprockets the shafts carried larger sprockets, upon which was laid the endless belt H, which was fitted with spikes or lugs to give it a grip on the surface of a road.

Steering was effected by moving the sled in front by means of a hand wheel, which was controlled by a man on a seat in front of the smoke-box door. The latest form of the Eau Claire firm's chain track, which, by the way, it calls the Centiped, is shown in Fig. 52. The roller chain, with rigid links, will be

noted. It will also be observed that the track chain is lifted off the roller chain, while going round the sprocket wheels

An engine of this type weighed 15 tons empty, or 18 to 20 tons in working order. With a boiler pressure of 200 lb. per square inch it developed 100 horse-

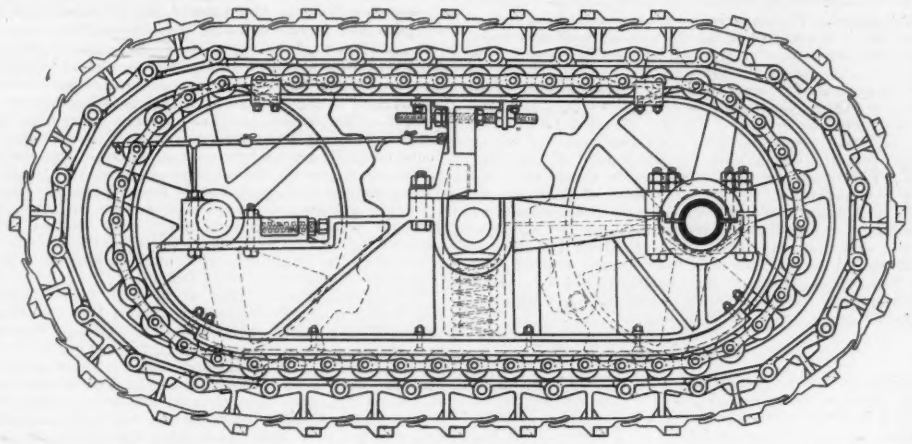

Fig. 52—THE CENTIPED CHAIN-TRACK

power, and had a speed of from four to five miles per hour. It could, apparently, work in rough country, but it needed easy gradients for satisfactory operation. On well-graded icy roads, however, it is said to have been able to handle from seven to fifteen heavy logging sleds, with 5000 to 7000 board feet of logs to the sled. In the early part of 1908 some thirty locomotives of this type were being used in Minnesota, Wisconsin, Michigan, and Saskatchewan. Some of them could cover fifty miles per day, and it is said that each could do the work of from twelve to eighteen four-horse teams.

It is interesting to compare this invention with the development of the Lombard machine, as depicted in the sketch, Fig. 53, which has been reproduced from one of the drawings in Mr. Alvin O. Lombard's

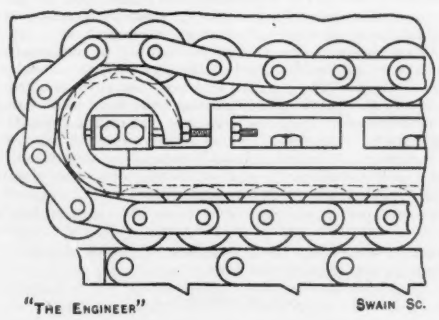

Fig. 54—IMPROVED LOMBARD ARRANGEMENT, 1913

United States specification, No. 854,364 of March 21st, 1907. It will be observed that the two engines—Phœnix and Lombard—possess a good many features in common, though they are not exactly similar. The special points to notice in the Lombard machine are, first of all, the apparent suppression of the roller chain and the substitution for it of larger rollers journalled in the frame, and secondly, the chain drive instead of the pinion drive. The steering of the engine was done, as in that of the Phœnix Company, by means of the sledge in front, and the steerer's seat was just in front of the smoke box. This engine was evidently for use on snow roads, and was furnished with projections on the endless driving bands so as to give a better grip. It is noteworthy, however, that Mr. Lombard, because he omitted the roller chain from his patent of 1907, had by no means relinquished this feature. Reference may here be made to a patent taken out in 1913—United States patent No. 1,063,364 of that year—which was for a special arrangement of chain and the guide on which it ran. One of the drawings from the specification is reproduced in Fig. 54. It will be observed that the rollers are connected together by inextensible links. We may say, too, that the traction links shown in the drawings of this specification are hinged together very much, as are the corners of a dove-tailed box, saving that some of the tongues are longer than others. This feature was also present in the patent of 1907. So far, therefore, from Mr. Lombard seeking to dissociate the various members of the traction chain from one another, so that they might take up indepen-

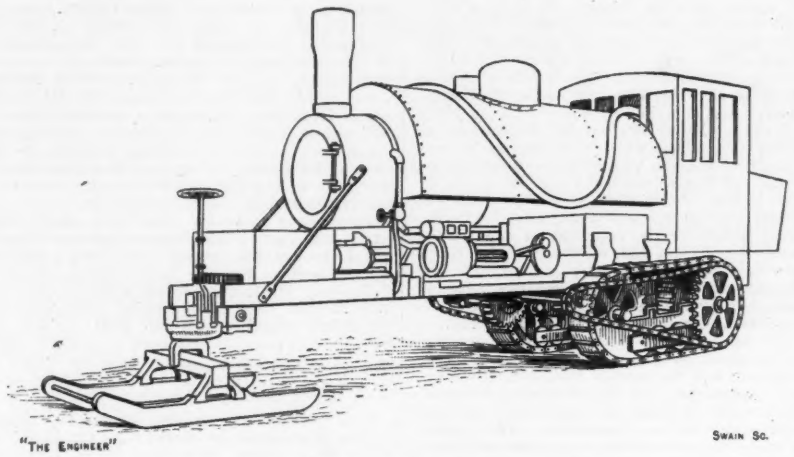

Fig. 53—THE LOMBARD LOG-HAULING TRACTOR, 1907

dent positions, in order to accommodate themselves to inequalities of the ground, he evidently intended that they should form a band which was only flexible at the hinges.

About this time, or earlier, the Holt Manufacturing Company, of Stockton, California, began the construction of chain-track tractors in connection with which its name has recently come so prominently before public notice. We are anxious not to do injustice to this company by giving its products a wrong date in this history, or by appearing to belittle in any way the excellent work which it has carried out. We believe, however, that we are right in saying that it was not the first in the field in the production of a really workable chain-track tractor. It is not quite clear, even, that it was foremost in the United States. The first public reference to such machines as being made by this firm was, to the best of our knowledge, made in the issue of the *Scientific American* for May 16th, 1908. Later in the same year the *Farm Implement News*, of Chicago, also illustrated Holt machines of this type.

The article in which the illustration appeared, referred to the Roberts' (English) chain-track tractor, and stated that it was not the first of its kind, as "several years ago" the Holt Manufacturing Company, of Stockton, Cal., produced an engine which, carrying its own track, could be run over sandy and soft roads and across fields where an ordinary traction engine would be mired. Some of the Holt machines were, it was stated, then in use on the aqueduct being constructed by the engineers for the city of Los Angeles. Each had a caterpillar on each side, and a single steering wheel in front. The petrol tractor weighed 7½ tons. It had a four-cylinder 40 horse-power engine of the automobile type. The sprockets of the caterpillar were at 6½ft. centres, and five small wheels between them held the bottom of the caterpillar in contact with the ground. The chain of the caterpillar was made up of pressed plates, 15in. by 8in., having grips on the outer side to give a good hold on the ground. The machine was 17ft. long by 7½ft. wide, and 10ft. high.

Doubtless, the Holt Company will correct us if we are wrong in what we have just said, and in what we are about to say, and we shall be pleased to insert any correction which it may wish us to make, together with drawings and particulars of its early and later machines. We do not know for how long a period this company had been making caterpillar tractors prior to the year we have referred to—1908—but we do not think it can have been very long, as otherwise the system would have been more widely known. This contention would appear to be upheld by the fact that in *The Canadian Thresherman and Farmer*—a Winnipeg publication—for April, 1909, an illustration was given of a "caterpillar or paddle-wheel traction engine," which we have reason to believe, though it is not so stated in the publication in question, was built by the Holt Company. The illustration is a half-tone engraving, and we give a reproduction of it in Fig. 55. Though this reproduction is not quite so clear as we should wish it to be, it shows fairly well the general design of the machine. The article which it helped to illustrate was on traction ploughing, and in the legend attached to the illustration the engine is described as being "one of the latest additions to this class of motor." It is explained that the wheels were encased in an endless chain of plates or paddles which furnished the wheels with a firm foundation to run over, and formed an endless track to run along with it. It was propelled by a steam engine of fifty horse-power.

It is worth noting that the name "caterpillar" is used to designate the machine, and to recall that it was nearly two years previously that our Tommies had applied the nickname to a Roberts machine at Aldershot.

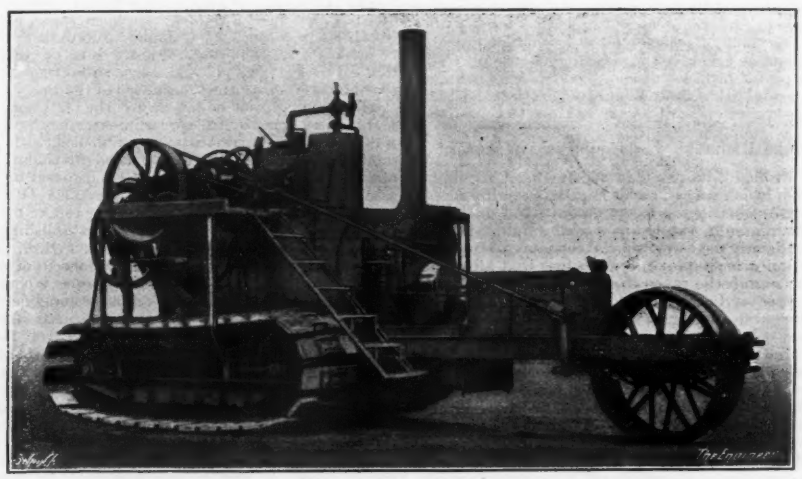

Fig. 55—CATERPILLAR, OR PADDLE-WHEEL TRACTION ENGINE, 1909

THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

(*Continued from page* 180.)

Size and Scope of Associations.

It is intended that the Research Associations should include as many of the firms in each industry as possible, but we recognise with Lord Crewe that "where there is so great a variety of applications as in the engineering industry, it may be found advisable to form a series of distinct associations for research purposes. On the other hand, it is quite possible that an individual great engineering firm having various activities of its own; might belong to two or three or more associations." When it is found necessary thus to sectionalise an industry, it will be important for the several Research Associations to combine for purposes common to more than one. We shall do all we can to encourage this co-operation between different associations, and we think that one of the most promising directions for co-operation of this kind is the preparation and circulation of abstracts of scientific literature and other information of technical interest.

Proposed Research Association for Cotton.

Substantial progress has already been made towards the establishment of a National Research Association by the great staple industry of cotton. On the day on which our last report was signed, our chairman and secretary met, by the courtesy of the Lord Mayor of Manchester, a few of the leading cotton spinners and manufacturers in informal conference. At an adjourned meeting held on 24th August under the chairmanship of Mr. J. W. McConnel, at which the Department was not represented, it was decided to ask the Advisory Council to appoint a Committee to consider the formulation of a scheme for research. Accordingly we appointed on the 29th September last a Provisional Committee which elected Mr. J. W. McConnel as chairman.

The Committee of Council have arranged with the Board of Education for the services of Mr. A. Abbott, H.M. Inspector of Schools, as secretary, and through H.M. Office of Works they have rented convenient offices at 108, Deansgate, Manchester. The Provisional Committee has met, with short intervals for holidays, regularly once a fortnight and has worked out a scheme of procedure in considerable detail. They propose the establishment of an Association for Research in Cotton that will include as members cotton spinning, doubling and thread making firms, cloth manufacturers, lace manufacturers, hosiery manufacturers, bleachers, dyers, printers, and finishers, and will conduct researches which include the study of the cotton plant at one end, and the "finishing" of the manufactured article at the other. The Memorandum and Articles of Association are in draft, and we hope that before many weeks are passed we may see the first co-operative association for research established under the auspices of the Department with every promise of a useful career.

Associations in Prospect.

We are glad to report that the woollen and worsted manufacturers of Great Britain have already appointed a Provisional Committee to draft the constitution for a Research Association. The Irish flax spinners and weavers have decided to take the same step; the textile industries are therefore well to the fore. The Scottish shale oil industry and the photographic manufacturers have decided to establish associations immediately, the electrical engineering firms and the British Society of Aircraft Constructors, in conjunction with the Aeronautical Society, have the matter under consideration, the Scottish shipbuilding and steel industries are moving, and we have hopes that it may be possible to establish an Association for Research into the non-ferrous alloys in the near future. We understand that the British iron puddlers and the Diesel engine manufacturers have independently established research organisations for the benefit of their respective industries. The coal mining industry is interested, as we point out below, but it will necessarily take time to organise this huge industry on a national basis. Several other industries, among them the pianoforte manufacturers, the master printers, and the cocoa industry have approached us. But there is a number of industries which for one reason or another are not so circumstanced that their firms are able to combine in this manner. In some cases the leading firms realise to the full the value of science and of a combined attack, but they cannot as yet carry the industry with them. This is the position for instance of the paper makers, who are urging us to establish a State laboratory to the initial and maintenance cost of which they are anxious to contribute.

Researches Unsuited for Co-operative Action.

There will remain, however, important fields for industrial research, which we can never hope to cover by means of Research Associations. Research into fuel is one of these. Every home in the land, as well as almost every industry, is directly concerned in the economy of fuel, and for that reason it is simpler and more just that all should contribute through the taxes to the cost of the research. The Committee of Council have accordingly established the Fuel Research Board as a part of the Department. Similarly we think the argument for a national board of research in timber will prove overwhelming; in both cases, however, we may hope to receive assistance if not contributions from some of the industries more immediately interested. The researches we are conducting through the British Fire Prevention Committee and the Concrete Institute respectively into the fire-resisting properties and into the general physical properties of different kinds of concrete, are also cases which call for national action. We have been assured that the same considerations hold good for the scientific problems underlying illuminating engineering and cold storage. Where the conditions make it unlikely that any particular industry will undertake necessary research it may be desirable for the Department to take action for the general good, with the help and assistance of the industries concerned. It will not be possible in these cases to delegate responsibility in the manner proposed for industries capable of combination in research associations.

The National Physical Laboratory.

There is still another class of scientific problems of great importance to industry, not susceptible of treatment by Associations for Research. We refer to the determination of constants and standards, whether physical, chemical, or bacteriological, and the accurate testing of manufactured products in the interest both of manufacturer and consumer. The range and importance of this work and of the research which it entails are certain to grow rapidly in the future. The experience of other countries goes to show that it is work which the State must itself undertake, or at least control, if it is to be adequately served. We welcome accordingly the arrangement recently made by the Committee of Council with the Royal Society, under which the Department will become financially responsible for the maintenance of the National Physical Laboratory. The scientific management of the Laboratory will remain unchanged, and the presence on our Council of Lord Rayleigh, Vice-chairman of its Executive Committee, will greatly facilitate our full understanding of the important work it is doing. We believe the new arrangement will strengthen in all directions the movement for which we stand, and that the Royal Society which brought the Laboratory into existence, and has watched over its growing strength, has done an equal national service in seeking the support of the Department of Scientific and Industrial Research in its future development.

The Fuel Research Board.

By far the most fundamental work initiated during this year, so far as the industrial aspect of our labours is concerned, has been the appointment by the Committee of Council on our recommendation of a Director of Fuel Research with a Fuel Research Board to assist him in laying his plans.

The question of researches bearing on coal and its uses had been before the Council in various relations since the beginning of 1916. Definite applications for grant had been received from professional societies and from research workers at universities. A Committee of the British Association, appointed to promote fuel economy, had also approached the Council with a view to applying for a grant, and it became apparent at this early stage that the great range and importance of research into fuel called for treatment in a comprehensive way. A memorandum on researches bearing on coal and its uses was accordingly prepared in May, 1916, at the request of the Council, and with the assistance of Sir Richard Redmayne (Chief Inspector of Mines under the Home-office). In July, 1916, the Reconstruction Committee appointed a Sub-committee on Coal Conservation, and the Council accordingly referred to that Sub-committee for their observations six researches that had been proposed to the Council.

A conference was held in September between representatives of the Coal Conservation Sub-committee and of the Advisory Council, at which the relations between the Sub-committee and the Council were discussed, and also the question of how to make the best use of the services of the British Association Committee on Fuel Economy. The conference agreed that the Advisory Council should be responsible for the organisation and conduct of all research bearing upon coal, whether initiated by the Coal Conservation Sub-committee or not.

The conference with the Coal Conservation Sub-committee was followed by another with representatives of the British Association Committee on Fuel Economy. It was proposed that the Advisory Council should establish a Standing Committee on Fuel to advise them as to proposals for research into the uses of fuel, and it was suggested that the membership of the new committee should be in a large measure identical with that of the executive of the British Association Committee. The Council accordingly appointed a small Sub-committee on November 3rd "to consider the constitution, *personnel*, and terms of reference of the proposed Standing Committee on Fuel." In consultation with the Chairman of the Council, and having regard in particular to the chemical survey of the coalfields of this country proposed by the Coal Conservation Sub-committee, and to the important and difficult developments in which this survey was certain to result, the Sub-committee reached the conclusion "that the magnitude and importance of the research work in fuel which will have to be undertaken either on the initiative of the Coal Conservation Sub-committee of the Reconstruction Committee, or of the Council itself, makes it essential to set up machinery which will be at once both more compact and capable of more rapid action than would be possible if the ordinary procedure were adopted of reports from Standing Committees to be considered by the Advisory Council, and then submitted by way of recommendation to the Committee of the Privy Council."

This finding was endorsed by the Advisory Council, and in due course by the Government, with the result that the Fuel Research Board was established, with a director immediately responsible to the Lord President, and with power to expend funds placed at his disposal by the Committee of the Privy Council in accordance with a budget annually approved by that body after report by us on his proposed scheme of work. On the establishment of the board, the services of Professor Bone, F.R.S., of the Imperial College, were retained, with the consent of the College Governors, as consultant to the board. We understand that the British Association Committee on Fuel Economy is prepared to place the valuable information it has collected at the disposal of the Fuel Research Board, and that the director may anticipate the active help of its members, either in their individual or corporate capacity as occasion may arise.

The Fuel Research Board have already presented their first report, outlining their proposals for taking stock of the coal resources of each district, classifying according to their qualities the seams which are being worked or which might, in certain circumstances, be worked, and ascertaining broadly the industrial uses to which the different kinds of coal are being put. It is intended, with the help of the coalowners, to collect typical specimens of the coal seams of the various coal mining districts, and to examine and classify them by means of chemical and physical examination in the laboratory. On the more theoretical side it is intended to conduct investigations into the nature and origin of the various types of coal and into the chemical and physical behaviour of their constituents under the action of heat and other agents, beginning with the well-defined types of coal as they occur in commerce. Thus, this side of the inquiry will be most readily kept in touch with the practical side, and the new knowledge of the scientific worker at once becomes available for practical application. This method of attack needs the establishment of suitable machinery for the supply of samples and not less the labours of a number of scientific workers. In present circumstances progress in both directions must be slow, but so far as more urgent necessities will allow, the director and the board will put this plan into operation during the coming year.

Peat.—The Fuel Research Board have also had under consideration a number of proposals for the utilisation of peat, and they have been in communication with the Department of Agriculture and Technical Instruction for Ireland. That department has for many years kept alive in Ireland an interest in peat and its possible uses and the Board cordially responded to its advances in this matter. At the same time the Board have not been able to ignore the experiences of the past and the failure of many schemes to attain permanent commercial success on any considerable scale. Accordingly they have decided after consultation with the Irish Department and with the approval of the Committee of Council to appoint a small committee of inquiry to sit in Dublin.

The committee will consist of Sir John Purser Griffith, M.A.I. (chairman), Professor Hugh Ryan, D.Sc., Professor Sidney Young, Sc.D., F.R.S., and Mr. George Fletcher, with Professor Pierce Purcell, M.A.I., as secretary.

Other Work of the Fuel Research Board.—The work of the Fuel Research Board, like that of the Provisional Committee on Research into Cotton, has been in the main preparatory. Neither body has yet done much in actual research, for they have been doing the careful thinking without which ideas are barren.

Domestic Heating.—We have, however, recommended that grants should be made for three pieces of research which are related to the work of the Fuel Research Board, and the Board have concurred, because they could be carried out without interfering with the general plan of operations. The first of these, initiated by the Sanitary Committee of the Manchester City council, is being carried on at the Municipal School of Technology, and has for its objects the use of better methods of domestic heating and improvement in the ventilation of dwelling rooms. A grant has also been given to the Institution of Heating and Ventilating Engineers to enable them (*a*) to tabulate and print the result of five researches on domestic heating carried out at University College, London, during the past three years, (*b*) to carry out a research with a view to establishing co-efficients of heat transmission through standard building materials, and (*c*) to conduct an investigation on heat transmission from radiators. We have invited the Institution to add Dr. Lees to the committee of direction, and as a member of the Executive Committee of the National Physical Laboratory he will assist them to avoid overlapping between the work to be done at University College and that conducted for some time past at Teddington into heat transmission through building materials of a light character.

Atmospheric Pollution.—The third grant made on our advice this year in the ultimate interests of fuel research will secure the continuance of the work begun in 1912 by the Committee for the Investigation of Atmospheric Pollution. The Committee was appointed by a conference held in that year in connection with an international exhibition organised by the Coal Smoke Abatement Society, and its work has been to collect reliable data as to (i.) atmospheric pollution and the causes producing it; (ii.) its results on public health, buildings, &c.; (iii.) the value of various means of counteracting it.

Conditions in Deep and Hot Mines.—One research aided by the Department has direct reference to the conditions of labour in mines. A grant made in November last to the Institution of Mining Engineers to enable them to investigate (*a*) the influence of hot and moist atmosphere on workers employed in mines, and (*b*) the methods to be employed for cooling and drying the atmosphere of mines will lead, we hope, to an improvement in the circumstances in which a large number of miners work. It is estimated that over a third of the 287,000,000 tons of coal produced annually in this country before the war was obtained from deep mines. An improvement in the working conditions in these mines will affect the health of many thousands of men and boys, and should greatly increase the total output. The experimental work of the research is being carried out in Dr. John Haldane's laboratory in Oxford and in other suitable laboratories. The underground observation is in charge of selected mining engineers and chemists. The whole cost of this research is for the moment borne by the Committee of Council, but we have recommended this "as an interim measure pending the establishment of more satisfactory arrangements," since we think the mineowners may reasonably be expected to bear a very substantial part of the cost of such investigations as these. We are glad to learn that since the grant was made the principal coalowners have been considering the establishment of a National Association for Research, which could undertake this and other researches affecting the industry. We shall welcome proposals in this direction which will supplement and articulate with the closely related work of the Fuel Research Board.

Mine-rescue Apparatus.—We have also undertaken a research, with the approval of the Committee of Council, having for its object the production of standard types of apparatus for mine-rescue work.

(*To be continued.*)

Revised charges and conditions as to wagon demurrage on the Irish railways came into operation on September 1st. Two clear days are to be allowed for the unloading of wagons containing coal and coke, and one day for unloading merchandise. A demurrage charge of 3s. per day for the first two days or portion of a day is to be made if detained beyond the mentioned time, and 6s. per day for each day after the first two extra days. Similar charges are to be made against traders who order wagons and then fail to load them within 24 hours after their receipt, or, if loaded, fail to order them away.

RAILWAY MATTERS.

A SPECIAL despatch to the *African World* announces the completion, in connection with the Cape to Cairo Railway, of the railway to Bukama on the navigable Congo. The line now covers a distance of 2700 miles direct from Cape-town *viâ* Rhodesia.

BUSINESS men and financiers in Montreal have petitioned the Dominion Parliament against the State purchase of the Canadian Northern Railway, on the plea that its acquisition will impose upon the country a drain of unknown magnitude. The Bill has, however, been read a third time.

THE Under Secretary for the Colonies stated in the House on August 20th that a survey had already been made for the extension of the Shire Highlands Railway northwards from Blantyre to Lake Nyasa, but it was impossible to say what route would be adopted, and when funds, material, and staff for its construction would be available.

As the new First Lord of the Admiralty, Sir Eric Geddes, has continued his contractual relations with the North-Eastern Railway, he is not drawing any salary from the Government. Mr. Bonar Law, in mentioning this fact, said that no doubt an opportunity could be found of criticising his policy other than in the usual way on the vote for the department.

THE North British Railway Company has, it is understood, agreed to increase by 10 per cent. the salaries of members of the staff who are in receipt of not more than £500, and are not participating in the war bonus of 15s. per week. The North British Company is almost singular, if not quite singular, among railway companies in that it pays the income-tax of those of its servants who are liable thereto.

SOME years ago an engine ran into the buffer stops at Harcourt-street station, Dublin, and, knocking them down, ran through the end wall of the station and fell into the street. History has now almost repeated itself. On Friday morning last a light engine was being moved in the engine-shed by a cleaner when it got out of control, and ran off the line at the end of the shed and through the wall into a garden.

RAILWAY fares in Victoria have been increased 10 per cent. in order to bring in an additional revenue of £252,000, and freight charges, except on coal, 10 per cent. also, which will provide an additional £248,000. The two sums make £500,000, which is the amount Mr. T. R. Johnson, who is inquiring into the working of the railways, recommends should be obtained in order to reduce the deficit for the current year, estimated at £750,000.

PHOTOGRAPHS of cars loaded below their carrying capacity are being sent to traders by the Baltimore and Ohio Railroad in an effort to increase the efficiency of its facilities as a war measure. The policy has been adopted as a part of a programme by which the company is making an appeal to utilise equipment to the utmost, thus assisting in overcoming the car shortage resulting from the requirements of the United States Government and the abnormal traffic resulting from business activity.

THE Industrial Commission, over which Judge Parry presided, that inquired into the conditions at Barrow-in-Furness, said that the housing problem in that town was "a crying scandal." At the outbreak of the war the population was 66,000, but now it is 83,000, and hundreds of workmen have to reside at Millom, nineteen miles away, and at Grange, twenty miles distant. For the accommodation of these workers special trains have to be run at various times of the day, and have put a great strain on an already overcrowded railway and a further tax on its locomotive power.

AT Sherman, on the Union Pacific Railway, there is a monument to Oakes Ames and Oliver Ames, the constructors of the first trans-continental railway. When the railway was re-aligned, some time since, the monument was left nearly five miles away, and it is now proposed to move it to a new site near Sherman Station, where it will be accessible to the public. When the rails were carried over the Rockies by the Sherman pass, at a height of over 8000ft., the work was considered one of the wonders of the world. Yet to-day the line is the lowest in the Rocky Mountains, and is known as "the easy grade."

THE Washington correspondent of *The Times* cables that the President of the United States is seriously considering the purchase of an extensive area of coalfields in Kentucky and of the Virginian Railway. The latter is the name taken by an amalgamation, effected in 1907, of the Deepwater Railway of Western Virginia and the Tidewater Railway of Virginia. The line runs practically east and west, and is 443 miles in length. It begins at Deepwater, Western Virginia, on the Kanawha River, in the Alleghany mountains, at a junction with the Chesapeake and Ohio Railroad, and terminates at Sewall's Point, on Hampton Roads, Norfolk, Virginia. The railway was mainly built by the energies of Mr. H. H. Rogers, the Standard oil magnate, whose death was considered to have been hastened by his hopes therein not having been quickly realised. Mr. Rogers had to part with many valuable securities in order to finance the Virginian Railway at a time when there was great financial depression.

A QUESTION was recently asked the Prime Minister as to in how many cases had railway officials of high standing employed by Government departments during the war continued to receive emoluments from railway funds in place of payments from the departments in which they served; whether this practice had been approved by the Treasury; whether it was considered and recommended by the law officers of the Crown and by the Controller and Auditor-General; and whether the Public Accounts Committee had recognised this form of payment? To this Mr. Bonar Law replied that, so far as it had been possible to ascertain, there were upwards of thirty railway officials of the rank of district officers and above who had been lent by railway companies to Government departments, and continues to receive remuneration from railway funds instead of being paid from public funds. He was not aware that the matter had come before the Treasury or the other authorities mentioned in the question.

NOTES AND MEMORANDA.

ACCORDING to the German technical journal *Licht und Lampe*, says the *Ironmonger*, the use of tungsten as the negative electrode in a cell having an electrolyte of sodium hydrate and a positive electrode of silver coated with mercury has given successful results. For accumulators, also, tungsten and its oxides may be usefully employed.

IT is reported from Toronto that the staff of the Department of Mining of the University has discovered a process by which low-grade concentrates of molybdenite can be made at low cost. The new process, it is stated, will render available the deposits of low-grade molybdenite ore which have been discovered in Manitoba and British Columbia.

FOR more than eighty years, says our American contemporary, *The Motorship*, no shipowner dreamt of sending a steam-driven vessel to sea on a long voyage without a considerable amount of auxiliary canvas. Yet after a couple of years' experience owners of Diesel-driven motorships have so much confidence in the oil engine that they would not think of carrying auxiliary canvas on a full-powered motorship.

STOCKS of steel plates, tin-plate, and galvanised iron are reported to be low throughout Australia, while the demand is acute. There is at present little prospect of outside relief, and an effort is, accordingly, being made to manufacture these goods in Australia. The Commonwealth Steel Products, Limited, which has just been registered with a capital of £250,000, proposes to erect works at Newcastle, N.S.W., for the manufacture of spring steel, railway wheels, and axles, &c.

DEALING with the losses of warships of all classes among the various belligerents, as reported up to July 31st, the *Army and Navy Journal* (New York) remarks that the gun is still supreme, as is shown by a tabulation of the causes of the various losses. By gunfire, 146 warships, all told, have been destroyed. Submarines have the next largest toll to their credit, having sent 138 warships to the bottom; and mines have the third largest number of victims, viz., 66. When it comes to actual engagements where gunfire is the deciding factor, Germany has suffered the loss of 91 ships by gunfire, while Great Britain has lost only 32. By submarines, however, Great Britain has lost 44 warships against 15 by Germany. Great Britain has lost 36 warships by mines, and Germany 6.

MUCH nonsense, according to the *Army and Navy Journal* (New York) has been written about the size and power of the latest types of U-boats. Reports of 5000-ton submarines being sighted are not regarded seriously by officers who have made a special study of these craft. The largest submarines reported with any official authenticity to date were of the 1200-ton type, armed with two 5in. guns. These seem to have been allotted the North Atlantic and the waters off the Irish coast as their special field. Information on file at the Navy Department would indicate that the number of submarines in active service also has been grossly over-estimated. Instead of the 300 vessels reported by the former German ambassador, there is good reason for believing that only 200 are on the German naval list.

A REPORT, quoted in the *Autocar*, leads one to believe that processes have been devised which are likely to result in the production of alcohol in large quantities in Switzerland by synthetic methods. It is stated that the problem has been solved, although its complete technical application cannot be worked out in less than about eighteen months. About 70,000 tons of calcium carbide are produced annually in Switzerland. From this source, assisted by hydrogen produced by electrolysis, alcohol can be obtained. A ton of alcohol results from the use of two tons of carbide and 500 cubic metres of hydrogen, involving the consumption of two and a-half tons of coal, four tons of chalk, and a further supply of fuel used in the generation of the necessary electrical energy. Hitherto, alcohol has only been produced synthetically from acetylene on a small scale in the laboratory. Its synthetic production on a commercial scale will therefore be watched with close interest.

THE construction of standardised ships of cast steel at the rate of more than one a day is advocated by a writer in the *Iron Age*. The plan, as described, is to build the ship hull in sections, each a casting as large as conditions will allow, and to weld the castings together electrically by an arc method. One casting might constitute the bottom of the vessel for a section of 8ft. lengthwise of the ship. Another casting would form practically one side of the hull for that section, and a third the corresponding side opposite. A fourth casting would form part of the deck framework of the stiffening between the upper part of the sides. By taking care in the welding that the steel is not allowed to get beyond the plastic stage in the heating, and that manganese is supplied through the soldering rods, it is claimed that the resultant welded joint has 125 per cent. of the strength of the casting itself. This shipbuilding project, it is declared, could be made to produce 6,000,000 tons of shipping per year.

EXTENSIVE projects for the introduction into Siam of systematic irrigation after the best modern methods have, according to *Eastern Engineering*, been on foot for the past few years, and a beginning seems already to have been made with their execution. The need of taking the matter in hand was recently emphasised by a bad rice harvest, and it was decided to engage the services of a competent irrigation engineer from outside the country to report on the situation and possibly to initiate work. The result was the loan by the Government of India of the services of Mr. T. R. J. Ward, C.I.E., an officer of wide experience in irrigation both in South Africa and in India. After a full study of the material already collected and a detailed survey of the ground, Mr. Ward formulated proposals for work to be put in hand at once, both in the plains of the Menam and in the basins of two other Siamese rivers. He points out that these streams form, in the lower Siamese plain, alluvial fans which lend themselves readily to irrigation so far as they remain above high-tide level. The Menam itself sends off three deltaic arms or distributories, which have in turn built up subsidiary fan-cones which can be irrigated by using the distributory as a main canal, developed and improved by suitable works.

MISCELLANEA.

A COMPANY has been formed at Christiania under the style of the Walmer Papyrus Pulp Company to utilise the papyrus which grows in North Zululand for the manufacture of paper pulp. The concession, says the *Anglo-Norwegian Trade Journal*, covers a period of twenty years.

IT is, of course, nothing new to learn, remarks the *Autocar*, that motor tire manufacturing concerns have acquired their own mills for the spinning and weaving of the fabrics required in their own tire factories. It is, however, interesting to read that one American tire firm has gone a step further and has acquired its own cotton-growing fields.

AN offshoot of an American abrasive manufacturing firm is erecting a large plant at Shawinigan Falls, Quebec, for the purpose of manufacturing carborundum and other abrasives. A contract has been made with an electric power company to supply 20,000 horse-power to the new undertaking. It is expected that the plant will be ready to operate at the end of this year.

AT the Kawasaki Dockyard, at Kobe, a 9000-ton steamer, complete with engines and masts on board, built for British owners, was recently launched in two months twenty-seven days from the laying of the keel. Within ten days of being launched her trials took place. Seven more steamers, of 9000 tons deadweight each, are at present under construction at the same yard.

THE Imperial Bagman again:—Passage from a telegram, which is reported to have been sent by the Emperor of Germany to the Czar, in 1904: "Before acting you ought not to forget to order new ships, so as to be ready with some of them when war is over. They will be excellent persuaders during the peace negotiations. Our private firms would be most glad to receive contracts."

SINCE the beginning of the war many new industries have been established in Great Britain, and goods formerly obtained from abroad are now being manufactured at home. The Department of Commercial Intelligence, Board of Trade, desires to make its record of such new industries as complete as possible, in order to satisfy inquiries for new sources of supplies, which are frequently received. Manufacturers are invited, therefore, to inform the Department of new industries, or new developments of existing industries, established in this country. The address of the Department is Basinghall-street, E.C. 2.

THE south-east pier in the transept of St. Paul's Cathedral is being surrounded with hoarding, and work in connection with the preservation of the fabric will begin as soon as three statues at the base of the pier have been removed. The work already done has, says the *Architect*, greatly added to the stability of the Cathedral. The south-west pier, which has been under repair for nearly four years, will, it is hoped, be relieved of its scaffolding in the next few weeks. Important documents recently brought to light show that the Cathedral authorities were faced by similar problems in a less critical form at the end of the eighteenth century, and that the building was then closed to the public for about a year and a-half.

AN important scheme for the allocation of £50,000 to research work and education was announced at the annual meeting of Messrs. Tootal, Broadhurst, Lee and Co. The expenditure is to be spread over a period of five years, and the policy of which this is the expression arises out of the declared belief of the directors of the supreme importance of research and education in the struggle for the world's trade. The scientific side of the work is to be kept quite separate from the existing works laboratory, and to undertake investigations which, while primarily intended to benefit the Company, are expected to prove of value to the cotton industry as a whole. The education side will be represented by works' schools for the employees of the Company, and promising pupils are to be assisted to take the university course.

THE Junior Institution of Engineers has instituted a "Cadet Associate Membership" whereby engineering pupils in works or college (day or evening students) may be registered for a nominal yearly fee of 5s. It is open to youths of fifteen years and over who are still undergoing training and who, as certified by a Principal of a technical college or head of department of an engineering works, are making satisfactory progress in the development of their abilities as engineer pupils. The registration as a Cadet Associate Member of the J.I.E. is for one year only, and renewals can only be accepted when satisfactory progress and development is vouched for by a responsible authority under whom the applicant is serving. The Institution undertakes certain duties with regard to these Cadets which are set forth in a pamphlet which may be obtained upon application to the Secretary, Junior Institution of Engineers, 39, Victoria-street, Westminster, S.W. 1.

THE annual report of the Crinan Canal Commissioners refers to the numerous representations which have been made as to the inadequacy of the existing canal, and the need for the construction of an improved and modernised canal in substitution for it. Such a waterway would be of great benefit to the trade and agriculture of the West Coast generally, and of the islands in particular. The Commissioners have themselves frequently drawn attention to the present unsatisfactory condition of the canal. The various works, constructed more than one hundred years ago, are in as good a condition as can be expected; but extensive repairs will have to be effected in the near future if the risk of a serious breakdown, involving the entire closing of the waterway, is to be avoided. The Commissioners have no funds which would be available for such repairs. In the year 1911, on instructions from the Treasury, a report was drawn up by Sir John Wolfe Barry and Partners, and an estimate prepared of the cost of putting the canal into repair. To reinstate the canal as originally constructed was estimated to require the expenditure of £31,650, and of certain improvements, including the removal of rocky corners and the deepening of the sea lock at Ardrishaig at an additional £19,700. The Commissioners ask that the question of the policy to be adopted should be taken into consideration without delay.

HORNSBY 60-H.P. CHAIN-TRACK TRACTOR ON TRIAL AT ALDERSHOT, 1910

(*For description see page 202*)

Fig. 56—THE TRACTOR HAULING A GUN ON UNEVEN GROUND

Fig. 57—THE TRACTOR HAULING A GUN UP HILL

Fig. 58—THE TRACTOR CLIMBING A HEAVY SLOPE

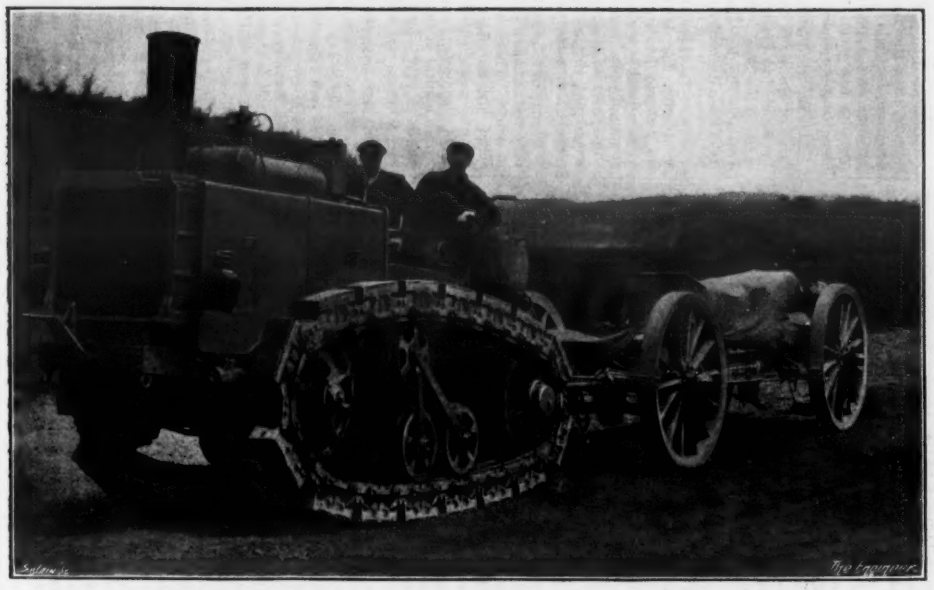

Fig. 56—VIEW OF TRACTOR, SHOWING CHAIN-TRACKS

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THE ENGINEER.

SEPTEMBER 7, 1917.

Industrial Research.

REVIEWING, twelve months ago, the first report of the Advisory Council for Scientific and Industrial Research, we expressed regret that it devoted itself principally to a review of the position opening before it, and gave an account all too brief of its stewardship. In the second report we find no grounds for criticism of the kind. Whatever may have been the temptations to indulge in generalities they have been avoided, and save for short passages here and there, to which no exception can be taken, since they illuminate the decisions of the Council, the report is a record of works well begun. It is true that less money has been spent than was anticipated, and we cannot but feel surprise that in a country which is crying out for research, a country in which organised research has hitherto been neglected, a country, above all, which must make haste to acquire knowledge of industrial value, the Council should have found it possible in the second year of its existence to expend no more than £14,500 odd, a sum which must be considered paltry when compared with the expenditure of other countries, and even of private companies, upon scientific investigations. The Department had at its disposal £40,000 voted by Parliament, and, frankly, we are sorry that it did not spend every penny of them either by more liberal grants when grants were made, or by expenditure upon investigations of an adventurous kind. The Department may properly defend its action with the plea that it was sound economy, but in a matter of this kind we suggest that the public is quite prepared to face a little wise extravagance, and that in any case forty thousand pounds sterling is a mere bagatelle.

We must not, however, lay too much stress upon the actual outlay of the Department. It is not by money alone that research will be encouraged, and if the Council has been able to induce an attitude towards scientific investigations which has hitherto been lacking, if it has been able to effect the co-operation of hostile forces, if it has been able to encourage associations to interest themselves in the work of inquiry, then it has done something which cannot be measured in terms of pounds, shillings and pence. The only means we have of judging how far it has succeeded in these respects reside in the report of the Council itself, and they are at once both satisfying and disappointing. They are disappointing, because there has not been that demand for assistance that we should have been glad to see, for it appears that the Council has had to consider only sixty applications for grants, for work of industrial importance, and of these it felt itself obliged to refuse five-and-twenty. The smallness of this number of applications can scarcely be regarded as a reflection upon the Department. In no small measure it may be due to the fact that the whole country is more concerned with the carrying on of the stereotyped needs of the war than with the search for new developments, but after making proper allowance for that fact, we cannot blind ourselves to the probability that our industries, long brought up in the spirit of individualism, are not yet able fully to grasp the advantages that are now presented to them, and that our research workers, grown accustomed to contempt, hesitate to plunge into new efforts which may only bring upon them renewed ridicule. In the course of time, both these arresting forces will be removed, and research will come by its own. The Department may do not a little to hasten that consummation by a little toleration, a little encouragement, even at the public expense, of that divine folly which sets out to seek things beyond the comprehension of the normally wise. It is possible that it has already done so in some degree, for if we understand it aright, it has beside the thirty-five grants already alluded to, made grants to thirty-six persons, of whom twenty-four are students being trained in research methods, ten are independent researchers, and two are research assistants. On what work the ten are engaged we do not know; but, perchance, some of it at least is of a purely adventurous kind. The Department has at its beck for next year £6000 to devote to these personal efforts, and we may hope that it will expend them without paying too close attention to the recommendations of its advisory committees. Committees rarely, or never, have any imagination. They do not see beyond their composite noses, they take hard facts and measure them by rule and line, they are lacking in the afflatus of the inventor or discoverer. Sir Frank Heath will do no harm if he over-rides them at times and squanders a few thousands on hair-brained inquiries. Still, we admit that may be better done in the future than in the present, when the first consideration must of necessity be to put our industries on a firmer footing, and there will, we think, be general approval of the decision of the Department to devote its attention for the moment to work which is likely to prove of immediate national benefit.

Of the actual work of the Department during the past year, we can say nothing that would add in any useful measure to the report of the Advisory Council, which is being reprinted, with few excisions, in our columns. Whoever will read it will see that many investigations of a really important kind have been entered upon, and will be constrained to admit that even if the Department has been a little too careful in the administration of its funds, it has directed its energies to the furtherance of researches which are of obvious value. He will observe with satisfaction that under its advice and with its encouragement and assistance, Research Associations are being set up, that a Fuel Research Board has been established by the Department, that the vexed question of concrete is being investigated, and that not only has the manufacture of glass been pressed forward with extraordinary success, but that an Institute of Technical Optics—a subject much neglected in this country—has been founded. The Department has also encouraged a general inquiry into National Resources, and has undertaken itself the survey of the metalliferous ores. In the field of private, as distinguished from national or industrial research, it has aided the Institution of Mechanical Engineers in its investigation of light alloys, hardness tests, and the flow of steam through nozzles, the Institute of Metals in its inquiry into the corrosion of condenser tubes, the Institution of Electrical Engineers in its inquiries into the heating of buried cables and insulating oils, and the Institution of Civil Engineers in its inquiry into the decay of dock materials in sea-water. These are but a few of its activities, of which the whole number is enumerated in the report; but they are sufficient to prove the point we wish to make, that it is to investigations which are likely to be of immediate benefit that the Department has given most of its attention. The report is, indeed, a record of good work, and we shall be surprised, indeed, if it does not bring home to the public a fuller appreciation of the usefulness of the Department than did its fellow of a twelve month past.

Standardisation of Marine Engines.

THE appointment of the British Marine Engineering Design and Construction Committee, which is to hold its first meeting at the Institution of Naval Architects next week, is a welcome sign that the marine engineering industry is using every endeavour to make provision for the conditions which will prevail after the war, as well as for the special needs of the moment. There is no room for doubt that both marine engineers and shipbuilders will experience an intense demand for a considerable period, and the adoption of a policy of standardisation should not only accelerate output at a time when rapid delivery will be an important factor in securing contracts, but should have the concurrent effects of improving the quality of the average product and reducing manufacturing costs. It is these desirable results that the Committee which has now been formed will take as a main motive of its deliberations. At the present time the machinery installations for the Government shipbuilding programme are being constructed to standard designs, which are, in some respects, of an emergency character. Whilst they are serving the purpose for which they were framed, that of putting into the water a large tonnage of merchant shipping at the earliest possible moment, it is felt that a permanent standardisation scheme should follow somewhat different lines. A beginning was made some months ago when the North-East Coast Institution of Engineers and Shipbuilders, stimulated thereto in large

measure by Mr. D. B. Morison, put forward a provisional specification for consideration by the industry, accompanied by the explanation that the danger of progress being stultified by the adoption of a standard design was to be obviated by an annual revision of the specification by an expert committee. Wide publicity having been given to this proposal, and ample time allowed for discussion, Mr. Morison presented a paper on the subject at the last spring meeting of the Institution of Naval Architects. A proposal was then advanced on the initiative of Mr. J. T. Milton that the whole subject should be referred to a Committee of that Institution, which it was felt could claim more than any district society, however strong, to represent the whole marine engineering industry of the kingdom.

This suggestion led to the formation of the Committee to which we have referred. The work of deciding the precise constitution and objects of the Committee was far from easy, and has taken four months to carry out, but it is admitted by those who are in close touch with what has taken place that the work has been well done. The need for securing the adhesion to any standardisation scheme of the Board of Trade and the Classification Societies was at once recognised, and a technical representative from the marine department of the Board of Trade, from Lloyd's Register, the British Corporation, and the Bureau Veritas will sit on the Committee. The main body of the Committee will be formed of four representatives of the Institution of Naval Architects and a similar number of delegates from the North-East Coast Institution, the Institution of Engineers and Shipbuilders in Scotland, the Liverpool Engineering Society, and the Institute of Marine Engineers. The important manufacturing interests of Barrow-in-Furness and Belfast will also be represented, but the Engineering Standards Committee, which deals with the standardisation of materials and not of design, will not be directly represented. The members of the Committee have not all yet been definitely elected, although it is probable that those who represented the various Institutions at the preliminary meetings may remain as permanent members. In the case of the North-East Coast this course has, it is understood, been already adopted, and the members of the Committee will include representatives of the industry from the Tyne, the Tees and the Wear districts, as well as a delegate from the scientific side. Other districts will in all likelihood adopt a similar plan, with the object of making the Committee representative of all interests, and it is hoped that from the Liverpool area may come shipowners' delegates as well as marine engineers, although a certain representation from users is already secured through the co-operation of the Institute of Marine Engineers, whose membership is mainly composed of sea-going engineers. The inclusion of the Barrow and Belfast sections of the industry adds the final assurance that the Committee is a national one in the full sense of that term, and gives good ground for hoping that unless there is disagreement within the Committee room itself, any recommendations made will meet with general approval. The risk of trouble within is, however, not one to be lightly disregarded, but, perhaps, the recognised need for framing a national manufacturing policy will outweigh any of the district jealousies which under normal conditions would probably prevent an agreement on the thorny subject of standardisation being reached, and the fact that all the leading Institutions are represented on the Committee is at least evidence of a desire to approach the question with an open mind.

The reference of the Committee is a somewhat wide one. The work delegated to it is to frame rules acceptable to the Board of Trade and to the Classification societies in connection with the design and construction of marine engines, boilers, condensers, auxiliary apparatus, propellers and shafting. The word "standardisation" is not mentioned, but clearly implied. For without some measure of standardisation it is impossible to meet fully the objects the Committee has in view. Considerations of safety and reliability must take the first place in any modifications of existing rules that may be found necessary; but it is essential that British manufacturers should not be unduly handicapped by unessential restrictions or regulations which inflate cost without corresponding advantages. The whole subject will have to be considered on its merits, but with full attention to all details, for it is practically impossible to set up standard specification for certain items without collateral modifications of others. At the same time there will be a general desire to retain as far as possible those standards and principles which have done so much to give British marine engineering the priority it enjoys. The underlying principle which guided those who were responsible for the drafting of the provisional specifications put forward by the North-East Coast Institution was the inclusion in the standard design of the best features of existing practice. Possibly that specification may form a starting point from which to review the whole question afresh, in the light of the most recent experience. If the best features are incorporated on a national basis, with provision for revision of design at regular intervals, an improvement can scarcely fail to result, and though it may involve sacrifice on the part of a few manufacturers and demand a display of a general spirit of compromise, it should be of great permanent benefit to the industry.

THE NICKEL DEPOSITS AND INDUSTRY OF ONTARIO.

No. I.

THE metal nickel, it has been stated, is not a necessity of life nor an article of universal consumption or use. Nevertheless, it may safely be averred that it is one of the most important of Nature's minor elements. For the time being, its degree of importance is without doubt under an artificial or temporary enhancement, for the world's war activities have called for a very great increase in its use. Apart from this, however, it is undoubted that the importance of nickel as an industrial material is rapidly growing, and that after the war is over the call for it may be expected to remain at a high level, although, perhaps, not at as high a level as that of the present. It seems certain, indeed, that the world will always be able usefully to absorb all the nickel which can be produced, and that, although its uses to-day are many and diversified, fresh and extended employment of the metal awaits only an increased production of it.

As a pure metal, the uses of nickel are not important. It is rolled into sheets for stamping articles, such as watch and cigarette cases, cooking utensils, and so on. It is drawn into wire for electrical purposes, such, for example, as the construction of sparking plugs and for leading-in wires. In certain European countries small coins of pure nickel are in circulation. Strictly speaking, the nickel used as a catalytic agent in the hydrogenation or hardening of oils—a use of the element which is already of great importance—is in the metallic form. It is, however, reduced to the metallic form by the oil-hardeners themselves being acquired by them in the form of nickel sulphate.

A somewhat more important outlet for nickel is its use as a surface coating for other metals, an employment for it dictated by the fact that it does not readily tarnish in air at ordinary temperatures. Its application as a coating for other metals is, of course, usually effected by electro-deposition. An alternative method stated to give a perfect coating is to heat a sheet of iron in contact with two sheets of nickel and to roll the three sheets into one. This procedure, resembling that formerly adopted for the production of Sheffield plate, has been followed to some extent in Germany in connection with the manufacture of kitchen utensils.

It is, however, as a constituent of various alloys that nickel reaches its highest degree of importance. Its chief use in this manner is its alloyage with iron to produce nickel steel. The influence of the nickel is marked, but varies greatly according to the degree to which it is present. The usual nickel steel of the engineer contains from 3 to 4 per cent. of nickel, and has an enhanced tensile strength and elastic limit with an unaltered degree of ductility. Nickel steel is used both for industrial and for naval and military purposes. Its industrial uses are of rapidly increasing importance. As a structural material, it is employed notably in bridge building, while for locomotive, marine, stationary and automobile engine construction it is in considerable demand. It is also being used for the manufacture of wire ropes, axles and railway rails, the latter especially for use in tunnels and on curves. Its naval and military uses are no less diversified, the chief being in the manufacture of armour plate, ordnance, projectiles, protective deck plating, and gun shields.

Non-ferrous alloys of nickel are numerous, and provide an outlet for the metal second only in importance to its use in steel. It is stated that the ferrous and non-ferrous alloys of nickel absorb from 80 to 90 per cent. of the world's total output of nickel, and that the non-ferrous alloys account for about a quarter of this percentage. The chief commercial non-ferrous alloys of nickel are those in which it is combined with copper, and with copper and zinc. With copper alone we get cupro-nickel, otherwise known as nickel bronze or nickel brass. This alloy is widely used as a jacket for bullets, the function of the jacket being to give a surface to the bullet that will not be destroyed by the rifling of the barrel. The same alloy, but with slightly altered proportions, is used in the minting of the United States 5 cent pieces, or "nickels." Alloys of nickel with copper and zinc give us "nickel silver" as used for so many purposes of domestic and other interest.

In addition to these non-ferrous alloys, nickel in alloy with chromium or manganese is extensively used in the form of wire for electrical resistances and for thermo-couples. Alloyed with copper, manganese and iron, it gives Monel metal, a material used for propellers, valves, and other objects in which high tensile strength combined with great resistance to corrosion is required. Finally, much attention is now being paid to alloys consisting of nickel copper and aluminium.

From the above brief summary of the principal uses to which nickel is at present put, a just conception of its importance to us may be formed. For the moment its importance is little short of vital, and after the war it will be little less so. A study of the world's sources of supply of nickel and the extent to which the British Empire commands the produce of these sources is, therefore, of the greatest interest.

As is well known, there are at present two chief districts whence nickel supplies are drawn. The first and oldest of these is the French island of New Caledonia, lying about 700 miles off the coast of Queensland. The other is in the Province of Ontario, Canada, the precise situation being the Sudbury area situated close to the northern shores of Lake Huron. These are the two principal nickeliferous areas. Nickel, however, occurs in many other countries. Indeed, as a constituent of the earth's crust, the metal is very widely distributed, and is said to form a greater percentage of the solid crust then either copper, zinc or lead. The natural agencies whereby the world's metals have been in places segregated into what we call deposits have, however, been less attentive to nickel than to either of the three other metals mentioned, so that nickel, judged from the distribution and extent of its workable deposits, is apparently less abundant than the others.

Beyond the Sudbury area nickel is found in Canada only at Alexo, 150 miles north of Sudbury, and at Cobalt, about 80 miles to the north-east. Next to Ontario, New Caledonia is the most important nickel-producing area in the world. The ore here has been worked since 1875, but since 1887 the industry has suffered considerably from the competition of Sudbury. Deposits of nickel occur in Norway and Sweden. In the latter the ores have not been worked recently. Mining in Norway began in the 'forties, but competition with New Caledonia, and later with Sudbury, resulted in the mines being closed until recent years, when, with the introduction of an electrolytic process of refining it was found possible to re-open them. The Norwegian output of nickel is not large and what there is of it goes, or went, principally to Germany.

Among other nickeliferous areas are Borneo and Cuba, each of which has deposits of iron ore, with which about 1 per cent. of nickel is associated. It is estimated that there are about 3000 million tons of nickeliferous iron ore in Cuba alone. The deposits may become of great importance. Already the Pennsylvania and Maryland Steel Companies in the United States are manufacturing from Cuban ore, on a commercial basis, a nickel steel which is stated to be superior to ordinary Bessemer and open-hearth steels, by reason of its nickel content and its low phosphorus. Rails made from the same ore are in use on the celebrated "Horseshoe Curve" of the Pennsylvania Railroad, and are reported to have established their superiority over ordinary rails.

Nickel also occurs in China and Egypt, but is not worked apparently on an extensive scale, or by modern methods. France, Italy, Spain, Scotland, and Wales also have small deposits of the ore, but they have either been worked out or are of insignificant extent. In Germany and Austria the deposits are larger, and a small amount of home-produced metal is available. Greece has fair deposits of nickel and nickeliferous iron ore, and—at least before the war—supplied some of the former to the Norwegian refineries. In Madagascar and in the Ural Mountains deposits of nickel ore are known to exist, and it is just possible that these may yet be worked on a moderately extensive basis. South Africa appears to have certain small deposits of fairly rich nickeliferous ore, but little has been done towards developing them. Rich small deposits also occur in Tasmania, the ore from which before the war was shipped to Germany. The ore occurs in numerous localities in the United States, but so far as is known at present the deposits are of little commercial importance, for they are not rich enough to use under ordinary conditions. A certain amount of nickel is, however, recovered in the process of refining native copper, a metal with which nickel is very frequently found associated.

For all practical purposes, then, the world is dependent for its supply of nickel on but two districts—Ontario and New Caledonia. From the Imperial point of view, it is no doubt gratifying to note that one of these districts—and now greatly the more important at that—is within the British Empire. The situation, however, is less satisfactory in reality than it appears on the surface. The fact is that at present the bulk of the ore mined in Ontario is sent to the United States for refining, and that through what many must judge to be indifference on the part of the British Government, and in particular on the part of the British Admiralty, the ownership of the nickel-bearing areas of Ontario has been allowed to pass largely into the hands of non-British subjects. It required, it seems, the clash of war to awake those in this country to an understanding of the significance of the situation. At any rate, it was not until September 9th, 1915, that the authorities bestirred them-

selves to appoint a commission to inquire into the whole state of affairs. The body appointed, the Royal Ontario Nickel Commission, consisted of G. T. Holloway, of London, vice-president of the Institution of Mining and Metallurgy; W. G. Miller, of Toronto, provincial geologist; M. Young, of Toronto, one of His Majesty's counsel; and T. W. Gibson, of Toronto, deputy-minister of mines.

This body was given a very wide commission. In fact, it may be said that it was instructed to inquire into everything having to do with the mining, refining, and use of nickel, with special reference to the deposits in Ontario, and generally with the nickel position of the whole world. By March 17th, 1917, it had concluded its labours and presented its report. That report has now been printed and circulated, and we have been favoured with a copy of it. It is, we think, one of the most interesting and valuable official documents which it has been our lot to study. It is a model of what such a report should be. It is, in fact, much less of a report than an exhaustive text-book on everything concerning nickel, and will remain, if we mistake not, the standard work on its subject for many years. The volume is handsomely bound in cloth covers, contains 865 pages of text, and is illustrated with many views, maps, and drawings. Its interest is by no means purely technical; it is refreshingly human, almost romantic in parts. It gives, for instance, the history of New Caledonia, an account of its discovery, in 1774, by Captain Cook, refers to its convict days, describes its fauna and flora, and the extraordinary mixture of nationalities composing its population, and, in short, draws a picture of the island in a style of no small literary merit. Elsewhere we hear of early nickel prospectors in Spain being captured and held to ransom by brigands. Hints and definite statements of high and low intrigue abound. We get evidence once again of how the Germans had worked their insidious way into what should have been the preserves of other nations. We learn of the grip which the notorious Metallgesellschaft had on the French, Norwegian, and Tasmanian nickel industries, and of the strong suspicion that all was not as it should have been in connection with the Sudbury output, even after the outbreak of the war. Did not the German submarine Deutschland, on its arrival at Baltimore, in July last year, make a boast of its intention to return with a cargo of nickel? Whether she succeeded in doing so we do not know, but if she did she certainly took with her Canadian nickel, which had been refined, as the bulk of the Canadian output still is in the United States. It was this very matter of the refining of the Canadian output in a foreign country that very largely led to the institution of a Royal Commission to inquire into the whole nickel situation, for the advent of war revealed the possible great dangers of the custom.

The history of the British Government's attitude towards the Ontario nickel deposits is of no little interest at the present moment. In 1875 the world's nickel resources were largely increased by the discovery and working of the New Caledonia deposits. Mining began in Ontario in 1886, and by 1895 the outputs of the two districts were about equal as measured by the refined nickel recovered from the ores produced. Ten years later the Ontario output was well ahead of its rivals. In 1915 the Ontario output reached over 34,000 tons, as compared with 2570 tons from New Caledonia. Three years after the opening of mining in Ontario, namely, in 1889, the great value of nickel as a constituent in high-class steel was established, and almost at once its use in the manufacture of armour plate suggested itself. In 1890-91 the Navy Department at Washington carried out trials with the new armour, and completely established its superiority over that previously in use. The use of the new armour for the British fleet followed in due course after prolonged investigation, but the curious fact to be noticed is that not until 1904 would the Admiralty use for the armour plate it required any nickel other than the New Caledonian.

In 1891 the United States Navy Department, convinced thoroughly of the value of nickel in armour plate, spent a million dollars in purchasing nickel matte from the Sudbury mines. At the same time, Germany, France, and Russia all adopted nickel steel armour for their navies. Naturally, a great demand set in for mining locations in the Sudbury area. The Ontario Government, seeing the nickeliferous areas passing thus largely into the hands of foreigners and private individuals, stopped all further sales while it communicated with the British authorities. Its scheme, whereby the Government of the United Kingdom might acquire a substantial, if not a controlling, interest in the Ontario nickel deposits, was laid before the British Admiralty. The Lords Commissioners speedily replied. "The suggestion," they said, "did not commend itself to them, and while appreciating the courtesy and consideration that prompted the offer, they did not anticipate any difficulty in obtaining sufficient nickel for the requirements of Her Majesty's service through the ordinary channels." They hoped, however, that the Ontario Government would for some long period to come retain under its control some of the lands in which the nickel ore deposits were to be found. This lack of foresight on the part of the British Admiralty finished the matter for the time being, and the Ontario Government, not having power to do otherwise, reopened the nickeliferous areas for sale in June, 1891.

In 1898 the Spanish-American war demonstrated the excellent qualities of the nickel steel armour carried by the United States battleships, and, as a consequence, an effort was again made to interest the British authorities in the Ontario nickel industry. This renewed attempt does not appear to have been carried through to completion. In any event, it came to nothing.

In 1904 Mr. T. M. Kirkwood, of Toronto, patriotically offered to sell to the British Government certain nickel deposits in the Sudbury area. He explained to the Imperial authorities that the Americans were buying up the nickel lands in Ontario, and that the areas he was offering were the only undeveloped properties on the market, and would soon pass into the hands of the Americans if they were not disposed of to the British Government. The Lords Commissioners of the Admiralty declined the offer, and declared themselves satisfied that no necessity existed for incurring a large outlay in the acquisition of nickel properties. The areas in question, it may be added, are now owned by the Mond Nickel Company, and one of the mines on them is among the chief of that company's present sources of ore supply.

At the same time, although they had declined the offer, their Lordships appear to have been roused at last to take some mild interest in the situation. They stated that they were taking steps to ascertain the suitability of Canadian nickel for the manufacture of armour plate. They did not think, however, that even in war time there would be any insuperable difficulty in obtaining Canadian nickel ore if necessary, and were satisfied that the position was already sufficiently safeguarded. Nevertheless, they were concerned in the matter to an extent which led them to inquire whether the Ontario Government could not retain rights over a considerable area of ore-bearing land or rights of pre-emption over the output in case of necessity. It was also suggested to the Ontario Government that it should be provided in future grants of nickel-bearing land that the company working it should be British, and should not pass under foreign control. The Ontario Government replied that all the known deposits of nickel had already passed into private hands, and were largely non-British owned; that there was probably very little, if any, undeveloped nickel-bearing land left over which it could retain rights, and that in any event to do so would be to stop prospecting, and would not be in accordance with the law, which declared that the public lands were to be open for prospecting. The mere power of being able to take possession of the output would, it was also pointed out, not be sufficient unless means of refining all the matte were available within the Empire. At that moment by far the larger part of the nickel mined in the Sudbury area was being sent to the United States to be refined.

This seems to have ended the matter for the time being. The Admiralty soon after came to the conclusion that Canadian nickel was quite suitable for the manufacture of armour plate, and as a result, kept more or less in touch with the situation. Thus, in 1907, it proceeded so far as to make inquiry as to what powers the Ontario Government possessed in case of national emergency of prohibiting the export to foreign countries of Canadian nickel ore or matte. The Canadian authorities replied that they had no power in this direction.

What followed on the outbreak of the present war is known to the public in its broad outlines. The demand for munitions threw a tax on the available supplies of nickel to an extent never foreseen by the Admiralty with all its wisdom. The British Government became alarmed at the possibility of Canadian nickel mined by non-British interests, and refined outside the borders of Canada, reaching the enemy. It allowed a year, however, to elapse before appointing, in September, 1915, the Royal Ontario Nickel Commission to inquire into the whole situation, and, particularly into the question of refining the matte in Canada. About the same time it took steps, in co-operation with the Canadian authorities, and, if we mistake not, with the Government of the United States, to safeguard Canadian nickel from reaching the enemy. What precisely these steps consisted of we do not know, but, among them, it is certain was the acquisition of a controlling or, at least, a large interest in the affairs of at least one of the principal Ontario nickel mines. Thus it did at the thirteenth hour what it had been urged to do by the Canadian authorities in 1891. It was exactly twenty-four years behind in its decision.

With the conclusions arrived at by the Royal Commission and other matters relating to the Ontario nickel industry, we will deal in a second article. For the time being we need only say that the Commissioners are convinced that the Ontario nickel deposits are more than sufficient to meet all the needs of the British Empire, and that the matte produced by smelting the ore can be successfully and economically refined in the province itself.

THE general manager of the Texas and Pacific Railroad has made a public appeal for laws to prohibit live stock from running at large. He says that his railroad killed enough live stock during the fiscal year to feed an army of 100,000 men for ten days.

THE DEVELOPMENT OF MACHINERY IN THE UNITED STATES NAVY DURING THE PAST TEN YEARS.*

By Captain C. W. DYSON, U.S. Navy, Member.

(*Concluded from page* 191.)

1907-1908.

The next naval appropriation bill provided for two battleships of the dreadnought type and for ten destroyers.

The battleships, later named the Florida and Utah, were very similar to the Delaware in hull lines, but of about 1000 tons greater displacement, requiring a slightly greater tow-rope power at low speeds and slightly lower tow-rope power at 21 knots than was required for the previous vessels.

In laying down the machinery arrangement plans, the fire-room arrangement of boilers and piping was practically duplicated, the boilers, however, being slightly increased in heating surface over the total heating and superheating surface of the earlier vessels, while no superheaters were installed, the Parsons marine turbine not being adapted to use superheated steam on account of the abnormally small radial blade clearances which must be provided in that turbine in the high-pressure stages in order to preserve, or rather realise, a good efficiency.

Following the British lead, the engine-rooms were laid out showing a four-shaft installation of Parsons turbines with H.P. turbines, both ahead and astern, on the outboard shafts, and L.P ahead and astern turbines on the inboard shafts. The inboard shafts likewise carried cruising turbines, a H.P. turbine on one and an I.P. turbine on the other, so that at low speeds the steam would just pass through the H.P. cruising, then the I.P. cruising, thence to both H.P. mains, finally through both L.P.'s to the condensers. At intermediate speeds it was admitted to the I.P. cruising direct, the H.P. cruising running in vacuo. At higher speeds both cruising turbines were cut out and ran in vacuo.

NECESSITY FOR CRUISING ECONOMY IN OUR BATTLESHIPS.

When the conditions under which our battleships must operate are compared with those which faced European nations in the period directly preceding the present great war, a war which they all evidently had in mind in the preparation of the machinery designs for their vessels, it is readily understood why they could afford to neglect any provisions for ensuring great cruising radius, while with us the necessity for providing the maximum cruising radius is imperative.

The former nations were providing for operations in confined waters such as the North Sea and the Mediterranean, where they were never far from their bases. The runs from base to station were short, and occasion might arise where these runs would have to be made at high speed. Refueling became a simple proposition. Under the conditions foreseen high speed was more desirable than cruising radius, and the latter was sacrificed.

Turning now to the conditions confronting us, we see the entire western half of the North Atlantic Ocean from the northern shores of South America to Greenland on our Eastern sea front, and the entire line from Seattle to Panama to the southward, and from Seattle to Honolulu, thence to Guam and on to the Philippines, and still further to Samoa, requiring our attention. The areas to be covered are great, and the distances to bases and from base to base in some cases are magnificent. Fuel economy is of the highest value, even predominates over high speed, as the refueling problem becomes a serious one, and the greater our bunker capacities and the greater the fuel economy of our machinery, by so much is the seriousness of the problem reduced.

It will be shown later how this question had an important bearing on the decision of the department as to the types of machinery to be fitted in some of our subsequent vessels.

Beyond the installation of Parsons turbines in these two vessels the only point of practical engineering interest was a change in the basis of design of feed heaters. The old empirical rule used for years in the design had been to allow one square foot of heating surface for every ten designed I.H.P. Such a rule took no account of the amount of heating medium, which in the case of naval vessels is the auxiliary exhaust steam, the temperature of the heating medium, nor of the amount of feed water to be heated. During the year preceding the designing of these vessels the Bureau of Steam Engineering had developed a feed heater which, when constructed, had been thoroughly tested out at the engineering experiment station under conditions of exhaust pressure and temperature corresponding to those used in service. From the results of these tests design curves were prepared, and from these curves the necessary surface for the feed heaters was obtained.

In connection with these tests comparative tests were made with and without whirler strips in the tubes, these whirler strips being nothing but ribbons of sheet copper twisted to a pitch of 6in. and inserted in the tubes, extending their full length. Those whirlers, by causing every particle of water flowing through the tube to be brought into intimate contact with the heating surface, increased the efficiency of the heater about 25 per cent.

The heaters developed from the design curves required a total heating surface for both heaters, inclusive, of 700 square feet, while those of the preceding vessels, under the old empirical rules, required 2100 square feet.

In service the new heaters, paradoxical as it may seem, have done much better work than the old ones, delivering the feed at considerably higher temperatures and eliminating the constant troubles of leaky joints that had formerly been experienced.

I am giving the above as an illustration of the beneficial results that may be expected, both in small and in large problems, by carrying out a series of well thought out experiments, and am happy to be able to say that this is only one of the many instances where the engineering experiment station has demonstrated its value to the

* From the *Journal* of the American Society of Naval Engineers.

Bureau of Steam Engineering, and through it to the naval service in general.

Of the ten destroyers two were fitted with Curtis velocity compounded turbines on two shafts, two with Zoelly turbines of a similar type, and six with Parsons turbines on three shafts. The Curtis and Zoelly turbines were newcomers in the destroyer field in this country, but from reports received at the time, the Zoelly turbine was in successful operation in the German navy. When these vessels were completed and put into active service, those with the Curtis and those with the Parsons turbines gave satisfaction from the very start. In a short time, however, the vessels fitted with the Zoelly turbines demonstrated that either our information from abroad as to the success of this type of turbine was incorrect or that the American builders did not understand its construction sufficiently well to build a good turbine. Both vessels gave trouble, but while these troubles appear to have been practically conquered in one of the vessels, in the other the turbines went from bad to worse, and are now being replaced with machinery of a different type.

The Navy Department, with these vessels, definitely adopted oil as the approved fuel for destroyers. The system adopted being that of "Pressure Atomisation," commonly, though erroneously, known as "Mechanical Atomisation." The air for combustion was supplied by turbine-driven blowers of the open type, this type of unit having come to stay.

These being the first installations of all oil fuel, they became the school of experience from which many practical points in handling oil fuel were learned. Among these may be mentioned the following as being practically basic necessities for successful fuel-oil burning.

1. Steady pressure in oil-fuel supply lines to burners.

2. Burners which will efficiently atomise the fuel, and, for boilers of the express type, throw a long flame.

3. High and steady air pressure in the fire-rooms, which prevents leakage of unburnt gases through the boiler-casing joints into the fire-rooms, and also provides a life insurance for the fire-room force by preventing flare backs of flame and blow backs of steam in cases of tube rupture.

4. High velocity of air entering furnaces to ensure intimate mixture with atomised oil throughout length of flame, thus preventing wreckage of furnace linings by heavy pulsation.

5. Efficient and large areas of fire-brick furnace linings, well secured, to prevent radiation losses and to increase furnace efficiency.

6. The absolute necessity of so locating oil burners that no unburnt oil can come in contact with boiler tubes or fire-brick lining of furnace if smokeless burning is to be obtained, and if the building up of heavy carbon deposits is to be avoided.

7. Ample air supply to ensure an excess of air when running at full power, as this excess is necessary to ensure smokeless combustion.

8. Avoid relatively high gas pressures in the boiler passes and uptakes, as such pressures render furnace conditions unstable and tend to produce pulsation with consequent destruction of furnace linings.

Magazine Refrigeration.

The dreadnoughts up to this time authorised or building were of the five-turret type with the magazines for one turret located between the engine and fire-rooms. In order to reduce the naturally high temperature of this magazine some system of artificial cooling was necessary.

Two systems have been tried out, one with closed air circulation and the other with the cooling medium circulating through pipe coils in the magazines.

Difficulty was experienced with the first system when first applied, due to the moisture in the air frosting up the air coolers through which the refrigerated air from the machines circulated. These cooler pipes would become heavily coated with frost, which is a most excellent non-conductor, and when so coated no further degree of cooling of the magazine air was possible. The persons operating the machines did not appreciate this fact, so, as the frost gathered, the machines were driven harder and harder until something would break.

Reports were immediately made laying all the troubles to "defects in design," when really the trouble was due entirely to operation. This criticism of "defects in design" is met with constantly whenever any troubles are experienced. The *personnel* are always held blameless, and quite naturally, as those operating the machinery are doing so to the best of their ability, and are loath to admit that the fault might possibly rest with them.

Following these ships, appropriation was made for the Arkansas and Wyoming, and for eight destroyers. The plans prepared for the two battleships were practically duplications of those for the two preceding vessels.

The Department did, however, invite bids on a layout of combination machinery developed by it. This differed from the ordinary type of combination machinery that that had been used in the merchant marine. In this latter machinery the reciprocating engines and the turbine combined with them each developed about the same power, the steam pressure at the turbine inlet being that which is usually met with at the exhaust of a triple-expansion engine, about 12 lb. absolute. With the ordinary merchant vessel the ranges of speed and power used in actual service is very limited, and the machinery can be designed for maximum efficiency within these ranges. With vessels of war of high or moderately high speeds the range between ordinary cruising speed and power and full speed and power is extensive, and the combination machinery must be so designed that the turbine will deliver power down to and, if possible, slightly below the cruising speed, in order that it may not cause a drag and an absolute loss in efficiency. To accomplish this it is necessary to design the reciprocating engines as compounds, but having the same ratio between the high and low-pressure cylinders as exists in the ordinary triple-expansion engine. The function of the low-pressure cylinder is then performed by the highly efficient low-pressure turbine. The initial pressure at the turbine at full power in such a case should be about 30 lb. absolute. The whole scheme really can be considered as one in which the comparatively inefficient H.P. turbine and L.P. cylinder are replaced by the much more efficient H.P. and I.P. cylinders and L.P. turbine.

Bids were received for such an installation, but it was decided not to go into the experiment at that time. About two or three years later, the French Government did install a similar arrangement in several of their new battleships. With this same year, 1909, the subject of electric propulsion first made its appearance on the naval stage. Mr. W. L. R. Emmet approached the Navy Department with proposals to fit electric propelling machinery on one of the new vessels, but the Bureau of Steam Engineering advised against it, considering that the new problem should be at least partially solved by installing and trying out an installation on a less important vessel before committing itself to its installation on a capital ship. The opportunity to do this did not offer until two years later.

The destroyers of this programme were all of the two-shaft design, four of them having improved Zoelly turbines, two, Curtis turbines, and two, Parsons turbines. The latter having a H.P. turbine on one shaft, a low-pressure on the other, and having only a single condenser, which constitutes a very weak point in these vessels.

These destroyers are the starting point for high cruising economy in destroyers, the General Board of the Navy having required that they should have a certain specified cruising radius at 15 knots speed.

This requirement necessitated other than ordinary cruising turbines to realise the necessary economy, and, therefore, as the speed of rotation at 15 knots was comparatively low, small compound reciprocating engines working in combination with the turbines were fitted, connected to the main shafting by disconnecting couplings. These engines were disconnected for speeds above 16 knots. The combination was an unqualified success so far as the resultant economy was concerned, a reduction in fuel of from 25 to 50 per cent. below that required for the main turbines only was realised, 49 per cent. at 10 knots, 37 per cent. at 13 knots, and 25 per cent. at 16 knots, results well worth the expense and slight complication involved.

Some of these engines were made reversing, but the majority were made non-reversing, which was the form preferred by the Department. Barring some slight troubles, everything worked well with the exception of a form of friction clutch which had been fitted on four of the vessels.

The history of this clutch is a very good example of the difficulties the inventor encounters in the development of a new idea before success is finally realised, and, being such, I will detail this history to you.

The clutch was oil-controlled of the single friction-disc type, and was designed by Mr. John F. Metten, chief engineer of the Cramps' Shipbuilding Company, in an honest and finally successful endeavour to meet the Department's specifications. These called for the small cruising engines to be coupled to the main shafts by couplings which could be connected and disconnected with the machinery in motion.

The clutch, as already stated, was of the friction type. The single friction disc of plate steel was thickened into a boss at the centre, and bolts passed through this boss, and a boss in the end of a short length of intermediate shafting fitted between the after end of the engine shaft and the forward end of the main shaft. The after end of this intermediate shaft was forged out into a Tee end, which was held up to and worked in a slot across the end of a disc on the main shaft, thus providing a flexible coupling to care for changes in alignment.

When the couplings were put into service the first troubles were experienced with the coupling disc, which would heat up under load and warp. To obviate this trouble the edge of the disc was divided into segments by slitting it, the slits cutting in radially for about 4in. The remedy was effective.

The next weak point to develop was the bolting of the disc to the shaft. These bolts were then made much heavier. The shafts then began to break at the point where the form changed from cylindrical to the Tee. This form of flexible coupling was then abandoned and a flexible coupling with entire circumferential engagement was fitted. Everything but the cylindrical portion of the shaft having had its inning and been corrected, the body of the shaft began breaking up badly and some of the shafts broke. The trouble was analysed as due to torsional vibration, and the shafts were at once discarded and replaced with new ones of heavier weight and larger diameter. Since all of these changes were made the clutches in all their parts have been satisfactory.

This year's appropriation also called for one collier. This vessel, the Cyclops, was fitted with reciprocating engines of the straight-port type, and, when finished and tried out, gave a very creditable performance. She is mentioned here because a sister ship was laid down the next year, fitted with mechanical reduction gear, and the year following, a similar vessel fitted with electric propulsion. These new forms will now be taken up.

Mechanical Reduction Gear.

For several years anterior to the date of which I am speaking, Sir Charles Parsons, in England, and Rear-Admiral George W. Melville, co-operating with Mr. John H. MacAlpine, under the patronage of Mr. George Westinghouse, had been investigating the possibilities of mechanical gearing for interposition between turbines and propeller shafting in order to combine the high efficiency of the steam turbine with the high efficiency of slow-turning propellers. This was not the first appearance of such gearing, however, as it had been used in a few instances years before, but for a quite different purpose. The earlier reciprocating engines were very heavy, of long stroke, and very slow moving, and the gearing in these cases was interposed to bring the revolutions of the propellers up.

Sir Charles Parsons already had an installation in successful operation on the merchant ship Vespasian. Mr. Westinghouse had built a unit and had carried out a very successful shop test, but as yet had made no marine installation. The Maryland Steel Company, which received the contract for the Neptune, the sister ship of the Cyclops, proposed to the Navy Department that the main propelling machinery be changed to turbines and reduction gear, and the Bureau of Steam Engineering recommended approval of the proposition.

As the installation was experimental, the contract was so drawn that in case of failure the turbines and reduction gear would be replaced by reciprocating engines similar to those of the Cyclops, and in order to allow of this the shaft lines and dimensions were so fixed as to allow the one type of machinery to be removed, and the other installed without change of line shafting.

The Westinghouse gear, as originally designed, had the pinion bearings carried on an I beam, which provided a certain amount of flexibility for the pinion shaft, and was supposed to take care of any small disalignment which might occur between pinion and gear wheel. Before the gears were built, however, this I beam was replaced by two hydraulic cylinders, to which the oil was pumped by the bearings, and which, by the oil pressure shown, gave an accurate gauge of the power being exerted.

Mr. Westinghouse, being before everything else an inventor, saw here his opportunity and allowed his inventive genius to run riot. He designed a new type of marine turbine, the first stage being an impulse one, the remainder being of the reaction type. The big difference between this turbine and the ordinary Parsons turbine was in the location of the backing turbine. This was in the same casing with the ahead turbine, but was directly forward of the H.P. end of that turbine, being steam-sealed from it by a dummy fitted with labyrinth packing. The backing turbine exhausted through the rotor drums to the regular exhaust outlet. This turbine was a failure from the beginning, as there was continual loss due to steam leakage from the ahead to the backing side, causing both loss in steam and in power. He designed a bridge control on the air-brake principle by which the main engines could be operated from the ship's bridge. This never won favour, and but recently a request has been received from the vessel to remove it. He installed Westinghouse-Leblanc water-sealed rotary air pumps. These pumps used salt water as the sealing medium and discharged it overboard. The loss of fresh water, due to the vapour which became entrained with this salt water and was then discharged overboard, was enormous. Everything about the installation which had been installed by the Westinghouse Company was a failure, with the exception of the reduction gears, which were unqualifiedly successful.

Later the turbines were removed and replaced with others of the same type, but greatly improved design; the air pumps were replaced with others using fresh water on a closed circuit as a sealing medium; and in order to improve the efficiency of propulsion, the gears were changed in order to reduce the propeller revolutions from 132 to 110 at full power. The new installation is now on the vessel, and, after passing through a few vicissitudes, is operating satisfactorily.

Let us now turn to a more pleasing picture. I refer to the installation of electric propelling machinery on the collier Jupiter. This installation was undertaken by the General Electric Company the year following the beginning of work on the Neptune.

This being also an experimental installation, the Navy Department guarded itself from loss exactly in the same manner as had been done on the Neptune. This necessitated the installation of only one main turbine and generator in order that the shaft lines might not be disturbed.

The generator turbine was of the G. E. Curtis type. The generator is totally enclosed, and the rotor has fans on each end which take air in at the bottom of the casing and blow it out through the windings, passing thence through a discharge duct on top of the generator casing. The exciting current for the revolving field is supplied to slip rings on the generator shaft by one of the ship's lighting sets.

The motors, one on each shaft, are of the induction type with a stator 120in. in diameter and a rotor 110in. They are located in water-tight pits which cannot be filled by water from below. Being situated directly under the engine-room hatches they are liable to be deluged with water from above, and the insulation of the windings is, therefore, made waterproof and are intended to give safe running when partially submerged.

The first turbine constructed for this job was not entirely satisfactory to the General Electric Company, and they voluntarily scrapped it and constructed a new turbine having very greatly improved blading. The results obtained with the new turbine showed much improvement, and the completed units were installed. Barring the coming adrift of an internal turbine bolt, the installation has been perfectly satisfactory since first tried out. It has been subjected to water, insulation has been injured so that a spark jumped from end of the armature to the other, the ship has gone through exceptionally heavy weather, and the installation is as satisfactory to-day as when first installed.

The next vessels to be contracted for, that is, battleships, were the Texas and New York, and the Navy Department was accused of having taken a step backward when it was decided to put reciprocating engines in these vessels. The reasons for this step will now be given. A careful study of the performance of the North Dakota and a better understanding of the factors governing propeller performance had assured the Bureau that no great economy of propulsion could be expected so long as the turbine builders adhered to what was at that time current turbine practice. That is, as pointed out before, they were sacrificing propeller efficiency deliberately in order to obtain a high turbine efficiency and so be able to hold down weight and space to the lowest possible limit. The Bureau, by its action, was attempting to force them into a change by which the greatest combined efficiency of turbine and propeller could be obtained, and, as later developments indicated, these efforts finally met with success.

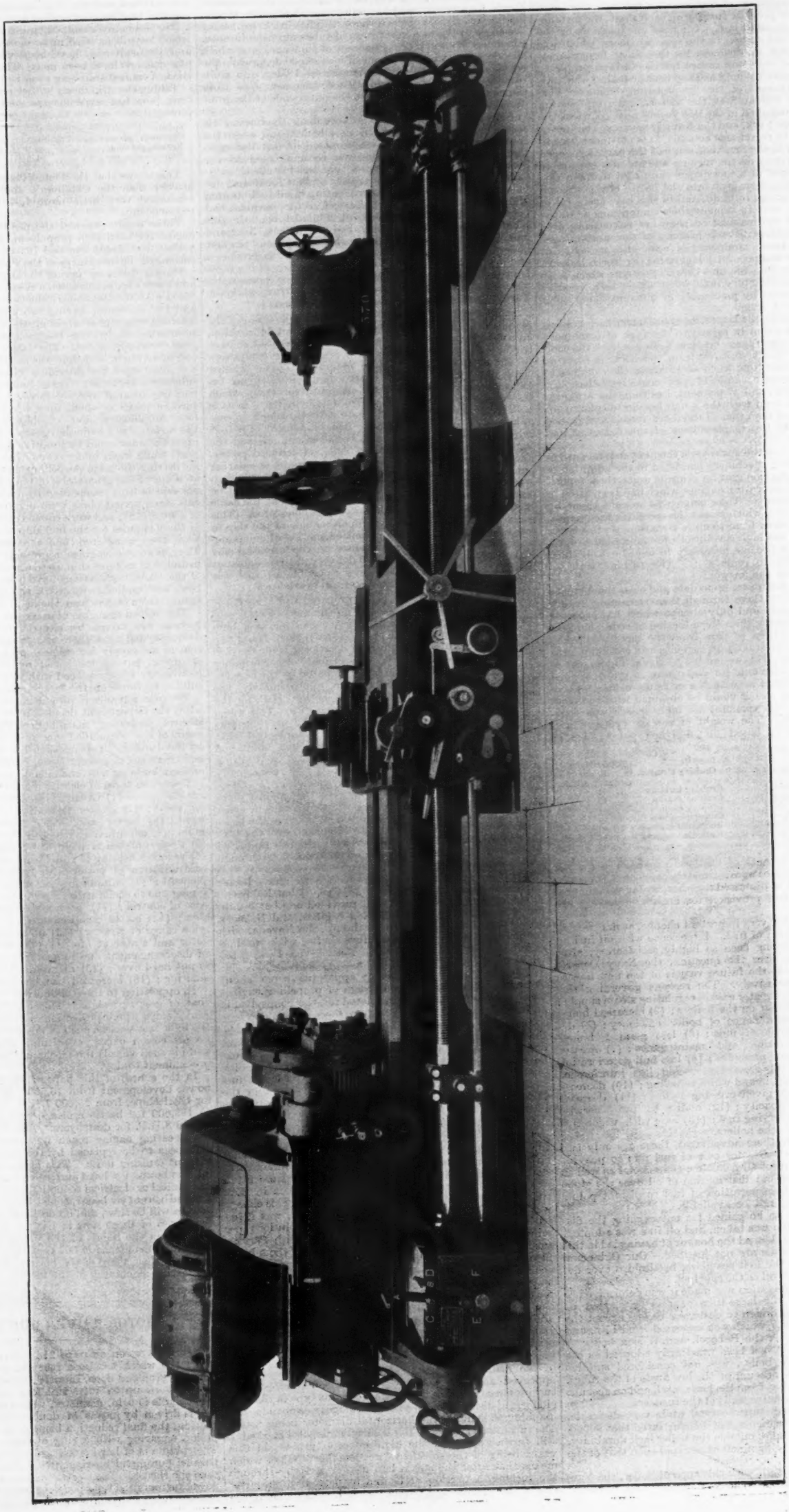
In furtherance of this idea, while the plans as prepared showed an installation of Parsons turbines, the Bureau unofficially informed some of the prospective bidders that a proposal to fit reciprocating engines would be given serious consideration.

When the bids were opened the Newport News Company was found to have submitted such a proposal and the Bureau of Steam Engineering promptly recommended acceptance. This action of the Bureau had not yet become public when parties interested in the Curtis turbine invaded Washington and began a vigorous campaign for that turbine, at first urging the installation of turbines similar to those they were then installing on the Argentine battleships Rivadavia and Moreno, turbines which had to be nearly completely re-bladed with a heavier type of blade than originally installed before they could even get through their preliminary acceptance trials. When they did finally pass these trials the water consumption trials at all speeds were far in excess of the guarantees. Later

FIFTEEN-INCH GUN LATHE

JOHN HETHERINGTON AND SONS, LIMITED, MANCHESTER, ENGINEERS

(For description see page 214)



in the campaign the advocates of the Curtis turbine proposed the installation of compounded turbines, that is, a high and a low-pressure turbine on each shaft, the installation to be a two-shaft one. The fight was taken up by the Bureau and was carried to the General Board, which was made the judge in the case by the Navy Department. No guarantees were too severe for the turbine people to meet, on paper, so long as they could equalise the estimated performance of the reciprocating engines. Fortunately, the Bureau was the victor, and reciprocating engines were installed in the two vessels now known as the Texas and New York, and the Navy Department has never had occasion to regret this action. It is pertinent here to call attention to the fact that some of the parties engaged in this controversy on the turbine side are now even more actively engaged in a newspaper campaign to force turbine-driven reduction gear into the battle cruisers which we are just starting to build, and in this case every bit of evidence they have to support their contentions as to the superiority of the installation they are advocating over that of the electric drive is hearsay of the most meagre description. These same parties were also strongly interested in the designs of machinery for the North Dakota, Salem, Henley, Duncan, and Downes, designs which have all proved unsatisfactory, and which either have been or are being replaced by machinery of different types or of greatly modified design.

As stated before, the Department has never had occasion to regret its decision in regard to the type of machinery installation for the Texas and New York, for from the coal-consumption reports received from the fleet, it costs no more to drive the New York at 12 knots than it does to drive the Delaware, and 17 per cent. less than the Florida and Utah, and 27 per cent. less than the Arkansas and Wyoming, even with the much heavier displacement of the New York than that of the three vessels first named and the slightly less displacement of the Arkansas and Wyoming.

Turning again to the destroyers, the next step forward in the design of their machinery consisted in the adoption of turbines and reduction gear for cruising units, these replacing the small reciprocating engines which had been fitted in the preceding classes. The change was brought about by the General Board, which raised the speed for the guaranteed cruising radius from 15 up to 20 knots. As this latter speed required too high revolutions for a reliable reciprocating engine, it became necessary to look for something that was reliable to replace it. The turbine with reduction gear was the answer.

To carry the destroyers up to date and clear them off the board, I will carry them through their remaining history at once. The next and only change which has occurred with their machinery since the adoption of reduction gear for cruising has been to pass from the direct-connected turbine main drive and adopt turbines and reduction gear for this purpose. This action led to the abandonment of special cruising elements for destroyers as quite a good (and nearly as good as with the cruising elements) economy at cruising speeds could be obtained with the main turbines, while the economy at high speeds was enormously increased. The weight of the six types of destroyer machinery, based on designed power, are as follows :—

Main propelling.	Cruising element.	Total weight, lb. per designed S.H.P.
1. Parsons turbines	Cruising turbines	51
2. Curtis turbines	Cruising nozzles	56
3. Parsons turbines	Cruising engines	47.5
5. Curtis turbines	Cruising engines	48
6. Parsons turbines	Reduction engines	46
7. Curtis turbines	Reduction engines	46.5
9. Geared turbines	—	42

As the developments of battleship machinery for the next two programmes were intimately connected, these two programmes will be discussed together, so far as main propelling engines and provision for cruising economy are concerned.

Taking up another very important change, at first we will turn to the question of fuel. Experience with oil fuel on the destroyers having been so highly satisfactory, after thoroughly going over the question, the Navy Department decided to fit the future vessels of the first line to burn oil fuel exclusively. The reasons governing this decision are :—(1) Greater ease in regulating steam supply ; (2) less wear and tear on the boilers ; (3) increased boiler efficiency ; (4) maintenance of boiler efficiency ; (5) decreased complement of men ; (6) less manual labour required in operation and maintenance ; (7) greater regularity in steam pressures ; (8) less hull deterioration from corrosion ; (9) greater ease and less interference with routine of ship, in and while refueling ; (10) decrease in fuel weight for given cruising radius ; (11) decrease in total bunker capacity ; (12) ability to use otherwise waste spaces for carrying fuel ; (13) ease with which fuel can be delivered to the boilers.

In opposition to these advantages, there are only two disadvantages :—(1) Greater cost of fuel due to possible limited supply to meet all demands, commercial as well as naval ; (2) less general distribution of oil over the globe necessitating the transportation of fuel to distant points where oil fuel may not be available.

The advantages to be gained far outweighing the disadvantages, the step was taken, and oil fuel was adopted. Other nations have claimed the honour of having led in this path, but their claims are not justified. Our Oklahoma and Nevada were the first sea-going battleships ever designed for the use of oil as the sole fuel.

When this determination was made it was determined to specify boilers of the large-tube express type, that is, generally similar in design to destroyer boilers except the diameter of the tubes, which was increased from 1¼in. and 1½in. up to 1⅝in., as the Babcock and Wilcox boiler as designed, and which had been practically adopted as the standard battleship boiler, was not considered suitable for oil-fuel work on account of the low angle of the tubes, which was only 15 deg. from the horizontal, and on account of the metallic side water walls of the furnace.

Having so decided, superheaters, while very desirable, were omitted, as experience has demonstrated that superheaters fitted in uptakes outside the boiler lack durability, their deterioration being much more rapid than that of the boiler.

The Nevada was built with this type of boiler, the Yarrow. The Babcock and Wilcox Company had, however, in the meantime given way to the wishes of the Bureau of Steam Engineering, and had redesigned their boiler, replacing the water walls of the furnace with fire-brick, increasing the angle of the two lower rows of tubes next the furnace, which were 2in. in place of one row of 4in. tubes, and which absorb the maximum amount of heat, to 20 deg., while the remainder of the tubes were angled at 18 deg. In addition, the boilers were fitted with downcomer pipes from the ends of the steam drums to the outer ends of the front cross boxes.

After these changes in design were made the Bureau felt assured of the success of the new boiler, and when the contractors for the Oklahoma proposed its installation in that vessel, favourable action was recommended to the Navy Department, and the new type was installed.

During the preceding few months a plant for testing out boilers under oil fuel, for experimenting in oil-fuel burning and for instructing men in the art of oil-fuel burning, had been erected at the Navy Yard, Philadelphia. In this plant had originally been installed two boilers, Normand and Yarrow, of the large-tube battleship type, and the first boiler of the Oklahoma type to be completed was purchased and installed in the plant. Comparative tests of the three boilers showed that the Babcock and Wilcox possessed a marked superiority in economy over the Yarrow, while the Yarrow was somewhat superior to the Normand.

The propelling machinery shown and specified was of the reciprocating-engine type, fitted with forced lubrication, and with two condensers per engine, one located at each end of the engine with a short, large-diameter connection to the adjacent low-pressure cylinder. These exhaust connections were fitted with accordion joints to care for expansion and vibration, and with gate valves by which the condenser could be cut off from its cylinder. In each L.P. receiver pipe was fitted a gate valve by which, in case of a badly leaking condenser or disarrangement of a L.P. cylinder, the cylinder involved could be cut out and the engine run as a three-cylinder triple, at reduced power. Each condenser had its own air pump and circulating pump. The air-pump channel ways were all cross-connected in order that any number of the pumps could be used as desired. The two circulating pumps at the same engine ends had their suctions cross-connected. This enabled suction to be taken from either side of the ship in case of grounding. It also permitted suction of one pump to be taken through the condenser on the opposite side of the vessel, using the outboard delivery of that condenser as a main injection. In fact, every possible measure was taken to render the ship immune from breakdown.

While the designs were being prepared the Fore River Shipbuilding Company appeared on the scene with a proposed layout of turbine machinery, consisting of a high and a low-pressure turbine on each shaft, there being two shafts, and with the revolutions decreased from the 280 of the North Dakota to 220. An estimate of performance of this proposed installation being prepared by the Bureau, it was found that it would require, approximately, the same S.H.P. for the different speeds as the I.H.P. for the same speeds of the reciprocating-engine ship. This was a large reduction in power as compared with previous turbine-driven vessels, and the Bureau recommended that this plan be accepted, requiring, however, that additional changes be made to give better economy at cruising speeds and securing the guarantees by abnormally heavy penalties. To obtain this economy, a cross-connection was to be provided between the exhaust pipes of the high-pressure turbines on the two shafts in order that, at reduced powers, steam could be taken in the high-pressure turbine on one shaft and exhausted into the L.P. turbine on the other, the other two turbines running in vacuo. This doubled the amount of steam flow through each active turbine, and so held up the economy. This fitting was never installed, however, as a much better scheme was developed with the next year's battleships.

The contracts, as carried out, provided one battleship, the Oklahoma, with reciprocating engines, and Babcock and Wilcox boilers, and one battleship, the Nevada, with compound Curtis turbines on two shafts, with turbines and reduction gear for cruising. Neither vessel was fitted with superheaters.

The change in the cruising apparatus came about through action taken on the design of propelling engines for the battleships next appropriated for, the Pennsylvania and Arizona.

During the preparation of plans for these two vessels, the Bureau of steam engineering was approached, and inquiries made as to whether turbine installations would be considered. The inquirers were told that if turbine installations promising an equal or nearly as low a fuel expenditure as the reciprocating engines, shown in the Department plans, preference would be given to the turbine installation.

To meet this requirement, the Curtis turbine advocates presented a plan having four shafts with high-pressure turbines on two inboard shafts and low-pressure turbines on the two outboard shafts. The Bureau informed them that if cruising turbines with reduction gear were fitted to the low-pressure shafts, exhausting to the main H.P. turbines, the installation would be approved. This change was made, and one vessel, the Pennsylvania, was fitted with Curtis turbines designed for 220 revolutions per minute, and the other vessel, the Arizona, with Parsons turbines of 240 revolutions per minute, both of them being fitted with cruising turbines and reduction-gear for economy at low speeds. These vessels were the first battleships ever laid down by any nation with this arrangement for cruising economy. Before the Nevada was completed the contractors, evidently fearing that the guaranteed cruising economies could not be realised, proposed to the Department that the means for obtaining this economy originally proposed be abandoned, and that cruising turbines and reduction gear installed on each shaft forward of the main turbines be substituted. This change was approved and the machinery so built. The Nevada's turbines marked a further advance for this type in that the old form of disc diaphragms between stages was abandoned ; diaphragms split on the horizontal diameter being fitted. The turbines, as fitted on the Pennsylvania, also marked a still further advance, the high-pressure turbines in this vessel being of the so-called "reverse-flow" type, which means that after the steam had passed partially through the turbine, a portion of it was by-passed to the after end of the turbine and flowed forward, thus reducing the steam thrust and also, if so desired in the design, decreasing the lengths of the blades.

The economy results obtained with the three vessels which have been tried up to date, the Nevada, Oklahoma, and Pennsylvania, have been very satisfactory, and all expectations have been met. The low-power results with the last-named ship may even be classed as remarkable.

Taking the Oklahoma's fuel consumptions as 100 per cent., the fuel expenditures were as the following percentages :—

Speeds	10	15	19	20.5
Oklahoma, per cent.	100	100	100	100
Nevada, per cent.	88.9	88.6	99.8	101.2
Pennsylvania, per cent.	91.5	103.6	101.4	101.6

This shows that the Pennsylvania, while over 3000 tons heavier than the Oklahoma and Nevada, on the trials consumed very little more fuel than the reciprocating engined ship.

These results marked the passing of the reciprocating engine for battleship propulsion, and the succeeding two vessels, the Mississippi and Idaho, were practically duplications of the machinery of the Pennsylvania and Arizona.

During this same period the Department contracted for and there were constructed a destroyer tender, the Melville, fitted with Westinghouse reduction gear, consisting of H.P. and L.P. turbines, driving two pinion shafts with pinions meshing into a gear wheel on the single main shaft ; and a submarine tender, the Bushnell, with Parsons reduction gear, similarly fitted. The latter vessel had, however, one innovation, and that was in the means taken to drive the generators for providing electric current to charge submarine batteries. These generators were two in number, one located directly forward, and in line with each turbine shaft to which they were attached by means of loose couplings, similar couplings also being fitted between the turbines and reduction gears. By this means both the main turbines could be used for driving the generators in port, while when under way either turbine could be used for driving the main propelling shaft while the other operated one of the generators, or both generators could be cut out and both turbines used to propel the vessel. During this same period plans were purchased for Diesel engines of 2500 S.H.P., and work started on the construction of two of these engines for the fuel ship Maumee. These engines have been completed, and the vessel is now in service. The Maumee's engines represent the maximum power installed in any one ship up to the present time. All three of the above installations have been satisfactory in operation, and undoubtedly mark the passing of the reciprocating steam engine from the field of auxiliary vessels.

The forced-draught blowers on the Oklahoma and Nevada are driven by electric motors, but trials have demonstrated that there is not sufficiently close regulation of air supply for efficient oil burning with this type of drive, having its speed regulation stepped. These blowers are to be replaced with steam-turbine driven ones similar to those on the later vessels.

The next advance in propulsion of capital ships occurred when the Department decided to fit the New Mexico with electric propelling machinery. This decision was the result of the unqualified success of this type of machinery on the Jupiter. This decision has since been adhered to, and there are at present seven battleships and four battle cruisers building with such machinery.

The advantages of electric machinery for such classes of vessels are :—(1) Greatly increased torpedo protection for ships ; (2) greater flexibility in machinery arrangement ; (3) better and wider separation of important units ; (4) minimum lengths and diameters of steam pipes ; (5) fewer bulkheads pierced by steam and feed piping ; (6) reduced heating of vessel from steam pipes ; (7) better centralisation of power ; (8) reduced engine-room complement ; (9) elimination of danger from fractures of piping due to shells striking protective deck ; (10) greater ease of control ; (11) greater flexibility in power distribution ; (12) better maintenance of economy through a wide range of powers ; (13) no metallic contact between rotor and stator of motor ; (14) eliminating all dangers of disarrangement due to shaft vibration, when the helm is put hard over ; (15) maximum reduction in length of shafting ; (16) increased backing power.

In opposition to these claims can only be advanced one, that of greater weight. This can be discounted on the heavy ships where protection is of vital importance. On the light fast vessels, such as destroyers and scouts, where no protection exists, everything is sacrificed for speed, and for such vessels the mechanical reduction gear stands pre-eminent to-day.

In the course of this paper I have taken you through power development from 16,500 I.H.P. to 60,000 S.H.P. for battleships, from 25,000 I.H.P. for armoured cruisers to 180,000 for battle cruisers, and from 7500 I.H.P. to 28,000 S.H.P. for destroyers. Also I have shown you the reciprocating engine reach its maximum efficiency and disappear to be replaced by the turbine drive with and without cruising units. This again, when highly successful, has bowed its head and moved aside that the straight mechanical or electrical reduction gear might take its place. The end has not yet been reached, but probably changes from now on will be slow, and no decidedly new type will usurp the places of those now in use for years to come. The future is in the hands of the young men of the Service, and every confidence is felt that they will not lag behind in taking their share of the burden in the development of the marine machinery of the future.

MOTOR-DRIVEN GUN LATHE.

THE illustration on page 213 represents a 15in. centre gun lathe which has been recently constructed by John Hetherington and Sons, Limited, Ancoats, Manchester, for taking work up to 12ft. 9in. long between the centres. The spindle is 6¼in. diameter, with a front neck 9in. long, and is driven by means of double, treble and quadruple gearing, the final reduction being obtained through a spur pinion engaging with a ring of teeth on the face plate. The spindle is of hard steel, and it revolves in adjustable parallel gun-metal bearings, with anti-friction washers to take the thrust. The electric motor, which is of 15 horse-power, is mounted on a pedestal behind the gear box, and has a range of speeds between 310 and 1930 revolutions

per minute. The lathe bed, which is of strong section, is carried down to the floor line under the gear box, and is supported for the remainder of its length on box feet. The top faces are fitted with square guides. The carriage has a long bearing on the bed, and is fitted with an apron at the front to carry all the gears for the feed motions. The whole of the gearing in the apron is of steel, and each shaft has a double bearing, while the motions are interlocked to prevent the simultaneous engagement of the sliding and screw-cutting motions, as well as to safeguard the feed motions when the taper turning arrangement is in use. Both the sliding and surfacing feeds can be reversed by the movement of a handle on the apron. The compound slide rest has an indexed swivel, and the top rest is of steel, with four studs and keep plates.

The screw-cutting motion is obtained through change wheels and reversing motion, and is driven from the end of the spindle in the usual manner, the guide screw being of large proportions, and well supported at frequent intervals. To engage and disengage the apron a long gun-metal nut is fitted. The feed motions are obtained through the gear box mounted at the fast headstock end of the bed, and four ratios are provided for both sliding and surfacing, giving 32, 16, 8 and 4 revolutions per inch of traverse. The changes are effected by means of two levers, and the gearing and clutches are of steel. The turning of tapers is accomplished by the introduction of an additional set of change wheels, with swing frame mounted at the loose headstock end of the bed. When this motion is in use the change wheels for screw cutting are selected to give the required traverse, and the levers in the feed box are set in the neutral position. A guide screw is used to provide the sliding motion, and the inward or outward movement of the slide rest is obtained by coupling the motion from the guide screw through the extra set of change wheels at the end of the bed on to the feed shaft, and thence through the apron gears and the surfacing motion. Any degree of taper from 1 in 2 to 1 in 300, with an almost unlimited number of variations, is obtainable by the change wheels provided with the lathe. The face plate is fitted with four adjustable loose dog slides, and a centre stay is provided for the bed.

The following are the chief particulars of the lathe :—

Height of centres, 15in.
Spindle diameter and length of neck, 6¼in. and 9in.
Gear ratios, 8, 32, and 128 to 1.
Spindle speeds 2.4 to 116 revolutions.
Movable headstock spindle diameter 4in.
Bed, length, width and depth, 20ft. 4in., 2ft. 1½in. and 16in.
Swings over carriage, 22in.
Approximate weight with motor, 11½ tons.

THE EXPLOSIBILITY OF METHANE-AIR MIXTURES.

SOME interesting experiments on the effects of temperature and pressure on the explosibility of methane-air mixtures, were recently undertaken by two officials, Messrs. Burrell and Robertson, of the United States Bureau of Mines. The results arrived at, while primarily of value to those connected with the coal mining industry, possess considerable interest for those, such as internal combustion engineers, concerned with gaseous combustion in general.

As is well known, a mixture of a combustible gas and air will not inflame if the gaseous content of the mixture is less than a certain percentage of the whole. In the case of methane, for instance, at ordinary atmospheric temperature and pressure a mixture containing about 5.5 per cent. of the gas or anything less cannot propagate combustion. The excess of the air in becoming heated up absorbs so much heat that the temperature of ignition of the methane is not reached. In the same way, if the mixture contains more than a certain percentage of gas, propagation is again prevented for an analogous reason. The question arises: to what extent, if any, are these limits affected by variations in the initial temperature and pressure of the mixture? So far as the lower limit for the methane air mixtures is concerned, answers to this are given by the results of the experiments referred to.

In the first series of experiments the initial pressure of the mixture was made constant at the atmospheric value, while the initial temperature was made in turn 25, 200, 300, 400, and 500 deg. Cent. At each temperature various strengths of mixture were examined until two adjacent values were found for one of which there was propagation, and for the other none. Between these two values the low limit of propagation obviously lay for the initial temperature in question. Thus in the 25 deg. initial temperature experiments it was found that a mixture containing 5.56 per cent. methane gave complete propagation, while a mixture containing 5.46 per cent. gave none. The full series of results is as follows :—

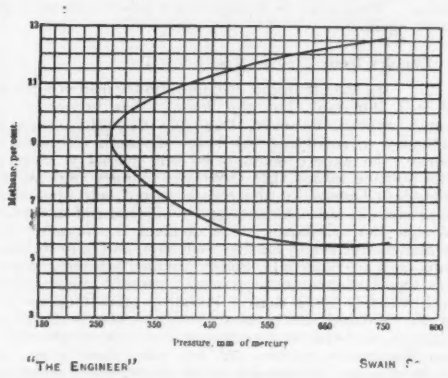
Pressure : Constant (Atmospheric).

Initial temperature. Deg. Cent.	Methane per cent. Propagation.	No propagation.
25	5.56	5.46
200	5.15	4.98
300	4.88	4.75
400	4.55	4.47
500	4.00	3.75

If the low limit be regarded as indicated by the mean of each pair of figures, it will be seen that as the initial temperature is increased the low limit falls. In other words, a mixture too weak to propagate ignition may do so when its temperature is raised.

The effect of keeping the initial temperature constant while the initial pressure was varied was then studied. It was found that at all pressures between 1 and 5 atmospheres the low limit of complete propagation remained constant. In other words, a mixture which is too weak to propagate ignition at atmospheric pressure will not do so if its pressure is raised, provided the temperature is not altered. This result confirms that of M. Taffanel, at Liévin, who found a similar state of affairs to prevail for hydrogen-air mixtures up to 40 atmospheres of pressure.

A similar absence of influence might be expected for pressures lower than atmospheric. Our ideas of continuity would certainly incline us *à priori* to this belief. Actually, however, while elevation of the initial pressure has no measurable effect on the low limit, reduction of the initial pressure has a very marked and curious effect. It was found that, stated generally, a mixture which would propagate ignition at one pressure could be made not to do so by lowering the pressure below a certain value. Thus, a mixture containing 5.59 per cent. of methane—at atmospheric temperature, say 25 deg. Cent.—will propagate ignition at all pressures down to 600 mm. of mercury. At pressures of and below 550 mm., however, propagation ceases. It may be assumed that the change from propagation to non-propagation occurs at the mean of these two pressures, namely, 575 mm. On increasing the strength of the mixture it was found necessary to go lower and lower with the initial pressure before propagation could be stopped. Thus, a pressure of 475 mm. had to be reached before a mixture containing 5.83 per cent. of methane would fail to propagate complete ignition, and a pressure of 385 mm. for a mixture containing 7.03 per cent. methane. This general rule continued until the strength of the mixture had risen to 9 per cent. methane, at which point a pressure of 275 mm. had to be reached before ignition could be stopped. Then came a curious inversion. As the strength of the mixture continued to be made greater and greater, it was found unnecessary to go so far with the reduction of the pressure. Thus, with a mixture containing 10.3 per cent. of methane, a reduction of the pressure to 375 mm. was sufficient to



"THE ENGINEER" SWAIN &

EFFECT OF PRESSURE ON EXPLOSIONS OF METHANE MIXTURES

inhibit propagation. A mixture containing 11.0 per cent. methane ceased to propagate ignition at 475 mm., and one containing 12 per cent. at 525 mm. In the accompanying diagram the results of the experiments are set out in the form of a curve.

The results arrived at are, it will be agreed, curious in some respects. From the curve given three points of interest, not specifically referred to in the report, may be deduced. In the first place no mixture of methane and air, whatever its strength, will propagate combustion—the initial temperature being atmospheric—if the pressure is less than about 275 mm. Secondly, the axis of the curve shown lies some small distance above the 9 per cent. line. In other words, a mixture containing a little over 9 per cent. methane propagates ignition over the maximum range of pressure. This is noteworthy because, theoretically, complete combustion represented by the equation

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

requires a mixture containing 9.4 per cent. methane and 90.6 per cent. air. Thirdly, it is apparent that the portion of the curve below the axis is the only part with which the investigation is properly concerned, for the portion above the axis depicts the effect on the *upper* limit of propagation of decreasing the initial pressure.

THE RAILWAY MEN'S SOCIETIES.

FOR many years there has been a lack of co-operation between the two unions in which railwaymen are to be found. At the time of the general railway strike in 1911 the action was united, but before the Royal Commission, which inquired into the trouble at the bottom of the strike, the recommendations made by the enginemen differed from those made by, what we may call, the rank and file. Latterly, the relations between the two societies have been very strained, and were greatly aggravated by the action successfully brought by officers of the National Union against the Associated Society for libel. No doubt, also, the greater progress achieved by the National Union has not made for pleasant co-operation. At the time of the threatened strike of 1907, when Mr. Lloyd George was at the Board of Trade, the Associated Society had 15,997 members. By the time of the general strike of 1911 the membership had increased to 19,800, and at the end of last year it had reached 34,039, a figure which represents an increase in seven years of 72 per cent. The National Union was not formed until 1913, when the Amalgamated Society of Railway Servants and two smaller societies were joined together. The first-named of these had 97,561 members in 1907, but after the conciliation boards were established there was a falling off, and at the time of the strike of 1911 there were only 75,153 members in the A.S.R.S., and 11,074 in the other two. By last year the membership in the National Union had grown to 340,511, or four times as many as the three unions, out of which it was constituted, had seven years ago. In any consideration of these figures, it must be remembered that the enginemen's society includes the most technical and the best paid men in railway service, and that at the end of 1913 there were employed on the railways of the United Kingdom 29,869 drivers, 27,343 firemen, and 19,150 cleaners, a total of 76,362.

THE INSTITUTE OF METALS.

THE annual autumn meeting of the Institute of Metals will be held on Wednesday, September 19th, in the rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. At the opening session, between the hours of 4 p.m. and 8 p.m., the following communications will be presented.

(1) "Experiments on the Fatigue of Brasses." By B. Parker Haigh, D.Sc. (London).
(2) "Hardness and Hardening." By Professor T. Turner, M.Sc., A.R.S.M. (Birmingham).
(3) "The Effects of Heat at Various Temperatures on the Rate of Softening of Cold-rolled Aluminium Sheet." By Professor H. C. H. Carpenter, M.A., Ph.D., A.R.S.M. (London), and L. Taverner, A.R.S.M. (London).
(4) Note on "A Comparison Screen for Brass." By O. W. Ellis, M.Sc. (London).

At the evening session, from 8 p.m. to 10 p.m., the programme will be as follows :—

(5) "Further Notes on a High Temperature Thermostat." By J. L. Haughton, M.Sc. (Teddington), and D. Hanson, M.Sc. (Teddington).
(6) "Principles and Methods of a New System of Gas-firing." By A. C. Ionides (London).
(7) "Fuel Economy Possibilities in Brass Melting Furnaces." By L. C. Harvey (London).
(8) "The Effect of Great Hydrostatic Pressure on the Physical Properties of Metals." By Professor Zay Jeffries, B.Sc. (Cleveland, U.S.A.).
(9) Note on "The Use of Chromic Acid and Hydrogen Peroxide as an Etching Agent." By S. W. Miller (Rochester, N.Y., U.S.A.).

In connection with Mr. Ionides' paper a demonstration of a new system of furnace heating will be given, and it is expected that this paper will give rise to an animated discussion on metal melting, a subject that aroused the greatest interest at the spring meeting of the Institute.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COAL ECONOMY.

SIR,—I note the letter by "Steam Raiser," in your issue of last week. If he is a constant reader of THE ENGINEER, he must have noticed a description of a CO_2 Indicator, which appeared a few weeks ago, and such is the type of instrument we are using.

You will be interested to learn that I have received several communications from steam users who have experimented with their boilers, by reducing the length of their furnace bars, a summary of which is as follows :—

One of the guardians of a Yorkshire institution states that since they reduced the length of the grate bars in the 30ft. × 8ft. Lancashire boiler, they have effected a saving of over 150 tons of coal during last year. A Yorkshire textile manufacturer writes :—"I have had the grates reduced in my Lancashire boiler since February, and I have effected a coal saving of from 5 to 7½ per cent., or a little over two tons per week."

The engineer of a pumping station says : "I have read your letters in THE ENGINEER with the keenest interest, and in support of your views, based on my personal experience, I may say I have long since adopted the system of shortening the fire-grates, with a view to getting the most out of the coal, and have got an increased efficiency as the result."

A Bradford engineer advises me that he has reduced the length of the grates of two 30ft. by 9ft. Lancashire boilers to 3ft. 6in., and is securing an evaporation of 9 lb. of water per pound of coal.

As some of your readers might not have had the privilege of going over the previous letters, with your permission I would like to point out that all Lancashire boilers 30ft. in length are fitted with furnaces 6ft. long; the ratio of outlet from the furnace flues to that of grate area varies from four square feet of grate to one of outlet in a 7ft. diameter boiler to 2¼ square feet of grate to one of outlet in a 9ft. diameter boiler, and I consider it is this lack of uniformity which produces the variable results I have found, and which range from 6½ lb. to 9 lb. of water evaporated per pound of coal of equal calorific value.

By gradually reducing the length of the furnaces, I found a marked improvement in results, and finally decided that the maximum was obtained with two square feet of grate to one of outlet, and to fit up the two boilers mentioned above with grates and outlets to this proportion, the 7ft. boiler would require grates 3ft. long, the 9ft. boiler would require grates 4ft. 9in. long, and if these two boilers were then tested with the same chimney draught and quality of fuel, each would give the same coal consumption per foot of grate and evaporation per pound of coal burned.

By reducing the length of the furnaces they are more easily worked by the attendant, and the excess air, which at present carries away 10 to 20 per cent. of the heat generated, is reduced by one-half, or in some cases more, with the natural result a higher furnace temperature is produced, black smoke minimised, and a greater evaporation per pound of coal secured.

There does not appear to have been any thought brought to bear on the subject of fixed proportions between grate area and area of outlet in the past, and yet without such uniformity the duty of our various boilers is nothing besides guess work.

W. H. CASMEY.

Wakefield, September 4th.

SOME EXPERIMENTS ON HOT BULB ENGINES.

SIR,—With regard to your contributor, Mr. R. E. Mathot's interesting and instructive article on the efficiency of hot bulb engines, I should like, with your permission, to make a few remarks with reference to timing, to which I propose to confine myself for the time.

The limit of power obtainable is reached when pre-ignition takes place, and in the present case, where pure air only is compressed, must, in my opinion, be caused primarily by the point of injection, and, incidentally, by the temperature of the bulb and compression.

In the case of a gas or petrol engine, no one would try to stop pre-ignition by advancing the spark, and yet this is in effect exactly what is done in many hot bulb engines.

The majority of pump gears, unless fitted with a by-pass relief, automatically advance the point of injection as the load increases, the finishing point being constant, this being the method most in favour by Mr. Mathot. On the contrary, I have observed from study of patent specifications, that certain prominent makers aim at fixing the point of injection in order to eliminate water injection, evidently realising that pre-ignition is the result of faulty timing.

I am rather surprised that Mr. Mathot placed no connection between timing and pre-ignition, but attributed it to faulty design of combustion chamber and bulb.

The object of admitting water is, of course, to reduce the temperature of the bulb and compression to admit of an earlier and longer injection period, which gives a considerable increase of power.

Providing the fuel has a small sulphur content, and the water is free from an excess of lime, I see no serious objection to its use except in the case of marine engines, where the additional storage accommodation and weight is a disadvantage.

CECIL H. COX.

August 30th.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Sheet Iron Trade and Ministry of Munitions.

THE opposition to the proposals of the Ministry of Munitions for restricting prices of sheets is not, as far as can be gathered, making much impression. The final step has not been taken, but communications between the authorities and the trade have so far advanced that some offers of business are declined on the ground that the limits which it is intended to apply leave no inducement to enter into further arrangements. Traders who have been in negotiation with the Ministry state that the maximum prices contemplated will leave no profit for rolling the sheets, as distinct from the initial manufacturing stage of producing the bars. Big houses which turn out their own bars may be contented with the profit on them, rolling the sheets at something like cost price in order to keep their workpeople together and their plant employed. But it is urged that millowners who have to buy their bars will be at a hopeless disadvantage; in other quarters the old quotations for black and galvanised sheets still prevail.

Finished Iron Conditions.

The margin of unsold output in the finished iron trade for the next few months is comparatively small. The special requisitions which are made upon ironmasters from time to time, too, for work of paramount importance render it additionally difficult to undertake regular deliveries on new contracts. At some consuming works it is impossible to make a full output, owing to lack of regular supplies. Merchants are in receipt of inquiries from regular customers for all descriptions of iron. But no matter what priority certificates may be tendered it is becoming increasingly difficult to find producers who are in a position to promise delivery, and business has to be placed practically without conditions in this respect. Current prices are:—Marked bars, £15 10s., less 2½ per cent.; Earl of Dudley's brand, £16 2s. 6d.; unmarked bars, £13 15s.; and North Staffordshire bars, £13 15s. The above are the maximum prices prescribed f.o.t. at makers' works net, except in cases of marked bars. Uncontrolled prices are: Gas strip, £15 10s.; hoops—iron and steel—£18 and upwards; black sheets, £19 10s.; galvanised sheets, £28 10s. to £29.

Pig Iron.

There is an active demand for both foundry and forge pig. Whatever the position may be in the Derbyshire foundries, there is no falling off in the pressure for Staffordshire foundry iron; the tendency seems rather the other way. More Midland furnaces are getting to work on the production of basic. Prices of all descriptions of pig iron are very firm at the full maxima, and some smelters are refusing business. Maximum prices continue at:—South Staffordshire common, 95s.; part-mine forge, 100s.; foundry, 102s. 6d.; all-mine forge, 115s.; foundry, 120s.; warm-air forge, 145s.; warm-air foundry, 155s.; and special quality, 167s. 6d., while cold-blast iron is 182s. 6d. North Staffordshire prices are: No. 4 forge, 95s.; foundry numbers, 97s. 6d.; and basic also 97s. 6d. Northamptonshire iron is quoted: No. 4 forge, 87s. 6d.; No. 4 foundry, 89s.; No. 3 foundry, 90s.; No. 2 foundry, 92s.; No. 1 foundry, 94s.; and basic, 97s. 6d. Derbyshire qualties are: No. 4 forge, 90s.; No. 3 foundry, 92s. 6d.; No. 2 foundry, 94s. 6d.; No. 1 foundry, 96s. 6d.; and basic, 97s. 6d.

Steel Trade.

The pressure for steel plates is so urgent that it is intended to divert to their production resources which are now being otherwise employed. In the semi-manufactured steel trade the output of raw material is so heavily requisitioned for purposes of paramount importance that the private contractor has to make shift with the best he can. Dependence upon the ordinary market agencies is much weakened. Hardly any imported material is finding its way on to the market. A cargo of American wire rods has just come to port, but it was sold before arrival at from £29 to £30 per ton.

The Wrought Iron Scrap Order.

The scrap business, which had been curtailed to an unexpected extent by some of the recent restrictions, is now put upon a new basis, which will make it better worth doing. The new order issued by the Ministry of Munitions, and which appeared in THE ENGINEER *in extenso* last week, revising the maximum prices allowed, has put the seller in a more advantageous position. There is a re-classification which will to some extent remove anomalies that were felt to operate unfairly. A maximum of £6 5s. is now fixed for wrought iron scrap, including not only three-eighths plates and sectional material, but ¼in. chains, &c., horseshoes, rivets, and bolts, and country scrap; this is a substantial concession on the schedule issued in March last. There is still a lack of sufficient supplies of iron and steel scrap. The modifications of the official restrictions will place those who have scrap to sell in a somewhat more advantageous position. But doubts are expressed as to whether the inducements are sufficient to revive the full activity of collectors of wrought iron scrap in the country districts. This source of supply is assuming increased importance owing to the draining of other sources under the abnormal conditions of the last few years.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE extreme tension of the demand for war purposes on the supply of finished steel continues, and instead of diminishing increases with every month. Possibly during the lull of the winter campaign the trade may find some easing off, for at any rate the daily expenditure will not be so great; but it would perhaps be rash to make this assumption, for which there has been no precedent during former winters. The scarcity of steel-making material is shown by the prices eagerly paid for shell-discard bars, which have now nearly touched £17 per ton. Billets, of course, cannot be obtained except for Government work, and their place is apparently taken by these discard bars and by plate shearings. Plate rollers are getting more for their straight plate shearings than for the new plates, or at any rate, more than the Government official price for plates, and this has been going on for a year and more. Why plate shearings should not come under the denomination of steel scrap is a mystery. It is rather amusing to see old iron boiler-plates limited to £6 5s. per ton, while steel plate makers obtain £11 15s. for their shearings. There have been reports about some reduction of price, or some movement of the nature of price-cutting in the American steel market, and perhaps this is a good omen. One would like to see the absurd and impracticable figures of the American trade brought down, and that for a good many reasons. So far, however, American importing firms are doing nothing here; or perhaps I should say there is no present appearance of action. They may be trying to get into touch with the trade again.

Foundry Iron.

In the Cleveland district foundry iron is reported as still abundant, but the demand has improved. It would appear, however, that the Committee has no difficulty in satisfying the home demand, although, of course, the export demand is only partially satisfied. The position means that Cleveland foundry pig can still come into Lancashire to a certain extent, and apparently does come in notwithstanding the objection of merchants to sign the certificate. The demand for foundry iron in Manchester is still on the small side, and only insignificant sales are reported. Sellers are not, however, anxious for large business, and apparently are still quite satisfied with what is being done. Probably more foundry iron of the Midland makes now goes into the Staffordshire districts, and this renders the makers more indifferent to the Manchester market. At any rate, there is not the slightest sign of weakening in the prices, which stand still at 98s. 8d. for Derbyshire No. 3, and 102s. 6d. for Staffordshire. The question is whether, if the dullness lasts through September, sellers will be more complaisant in the matter of prices, but the probability is that they can go on with their indifference quite a long time yet. Scotch iron for foundry purposes is certainly scarcer, and were it not for the small demand probably some inconvenience would be felt here; but the production of textile machinery is largely in abeyance at the moment, and many ironfounders have learned to do without a mixture of Scotch.

Scrap.

Really the only interesting point in the market at the moment is the probable result of the Orders issued last week in regard to the sale of scrap. Criticism of these Orders takes rather a contemptuous tone, and it cannot be denied that there are many evidences of the amateur hand. The two main articles dealt with are steel turnings and wrought scrap. With regard to the former the opinion is expressed that the new and higher maximum of 70s. will very soon be as obsolete as the old maximum of 50s. The reason of this is probably that consumers using steel-making material have found that they can utilise the turnings, and especially the heavy turnings, almost as well as ordinary heavy scrap; and as the latter is fixed at 105s. they have naturally tried to get as much weight of turnings as possible at the lower price. If this be so there is nothing to prevent turnings from being so scarce as to be unobtainable while the difference of 35s. per ton remains in operation; and the eventual result must be a scramble in which consumers will pay more than the new official price just as they did when the figure was 50s. With regard to wrought scrap the failure seems to be in classification and in the refusal to recognise that there is a great difference in value between various classes. At present it is too early to say what the effect will be on prices, but already we have dealers here quoting £7 per ton ex-yard for ordinary good quality heavy scrap. Last week they could ask only £5 15s. for the same material. So far as I have been able to discover consumers have not yet paid £7 to a dealer, but their hunger for scrap is such that they probably will very soon, unless some quantity of railway wrought scrap should be released. This a railway company or a merchant dealing in it would have to sell at £6 5s. or £6 5s. plus 2½ per cent., notwithstanding the fact that the scrap itself is usually much better than that which comes out of a dealer's yard. This is one of the absurdities of the situation. There are many others, but we have not space to go into them. The ordinary heavy melting steel scrap is dull and barely saleable at the official price of 105s. on trucks, and, of course, this is not surprising if turnings answer for it equally or nearly as well. There is no particular movement in foundry scrap, which is held for 102s. 6d. so far as ordinary fair quality is concerned; 105s. to 107s. 6d. for good engine metal, and up to 112s. 6d. for the best lots of textile scrap.

Coal Gas for Commercial Vehicles.

The Manchester Corporation Gas Committee has decided to make arrangements for the supply of coal gas for the propulsion of motor vehicles. Owing to the increasing scarcity and the high price of liquid fuel at the present time, the possibility of obtaining coal gas as a substitute will, no doubt, be greatly appreciated by owners of heavy commercial vehicles, of which there is a large number in this district. For the present, it is only intended to supply the gas from the different gasworks at atmospheric pressure, so that the range of operations of the vehicles will be restricted to something like 20 miles, owing to the limitation imposed by the size of the gas bag. The gas will be sold at the rate of 4d. per 100 cubic feet, and 250 to 300 cubic feet of gas are equivalent to a gallon of petrol for power purposes; the cost of fuel will correspond to about 10d. per gallon for petrol. The use of compressed coal gas is at present impracticable, owing to the difficulty of obtaining the necessary containers, but when this difficulty has been overcome, no doubt the Corporation will be prepared to lay down the necessary compressing plant, so that the range of operations of the vehicles can be greatly extended.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is marked activity throughout this district in the hematite pig iron trade. In Cumberland, with the miners back at work, the output of iron is being raised to the normal level. In North Lancashire there was no cessation of activity. There is a very heavy demand for iron, not on local but on general home account. The big bulk of the iron made at Barrow goes into immediate consumption, and much the same is the case from the Combine furnaces at Workington. There is need for a heavier output of iron; but this is not possible as yet, although there are hopes that there will be a fuller supply of ore, particularly in Furness. The Steel Controller has urged upon all concerned the necessity of very materially increasing the output of Lancashire ores. Prices are maintained at the maximum level, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton, and special brands at 140s. per ton f.o.t. There is nothing being done in warrant iron, and the stores remain at 450 tons.

Iron Ore.

The demand for hematite iron ore is very urgent, not only on local but on general home account. Local smelters are pressing for fuller deliveries of metal. There is rather more activity at some of the mines. The demand for foreign ores is steady.

Steel.

In the steel trade there is a busy state of affairs. The whole of the attention of makers is being given to rolling or casting material for work of national importance, and all other business is very much in the background. The steel foundries are very fully employed. Prices are at the same level, with heavy rails at £10 17s. 6d. to £11 per ton; light rails, £14 to £14 10s.; heavy tram rails, £14; ship plates, £11 10s.; boiler plates, £12 10s.; and billets, £10 7s. 6d. per ton. Engineers, shipbuilders and iron and brass founders are as busy as they can be.

Fuel.

For coal there is a very full demand, and steam sorts are at 25s. to 27s. 6d. per ton, with house coal at 27s. 6d. to 37s. 6d. per ton delivered. For coke the demand is urgent; East Coast qualities are at 33s. to 35s. 6d. per ton delivered, and Lancashire sorts are at 31s. per ton delivered.

SHEFFIELD.

(From our own Correspondent.)

The Fall of Riga.

FEW industrial centres in this country, I should say, are more concerned about the advances of the enemy against Russia than is Sheffield, for the interests of many firms here are intimately related to those of our Northern Ally. It is not only that the armament firms all have important capital invested there in the shape of works, but some of Sheffield's purely industrial concerns have large manufacturing connections in the country. But the fall of Riga must be a rather serious matter for one great Sheffield house—that of Thomas Firth and Sons, Limited. Firth's works at Riga cover an immense area, and are of the most modern description. They include a large steel-making plant, a shell-making department, and splendid rolling mills, whilst the file-making works are considered the finest, as they are probably the largest, in Europe. But if the Germans—who, of course, knew all this well enough—expected to find these intact they have been sorely disappointed. The thing that has now happened through the unwillingness of some of the Russian regiments to make a stand was really expected two years ago, and on that occasion practically all the machinery and plant was discreetly removed and the place closed down. As to where they were taken is not a matter for discussion here, but it is comforting at a disappointing time like the present to be assured that what the Germans will find, or have found, is a dismantled works. I believe the Riga establishment included a rail mills, but of that, at the moment of writing, I am not certain. Other firms are indirectly concerned, for John Brown and Co., Limited, hold seven-eighths of the ordinary shares in Thomas Firth and Sons, and both firms have close relations with Harland and Wolff's, of Belfast, Lord Aberconway, the chairman of Brown's, having a seat on the directorates of Firth's and Harland and Wolff's. Just in much the same way, it will be recalled, Vickers Limited, in conjunction with Armstrong, Whitworths, had launched a big shipbuilding and repairing scheme at Constantinople when Turkey joined the Central Powers as an ally. But these great concerns provide against contingencies even of this stupendous nature and will weather the storm all right.

Sheffield-Frodingham Development.

From an official source I learn that the negotiations referred to in a letter a few weeks back, between the amalgamated firms of Steel, Peech and Tozer and Samuel Fox and Co., of Ickles and Stocksbridge respectively, and the Frodingham Iron and Steel Company, North Lincolnshire, have just been successfully concluded. The Ickles and Stocksbridge combination brought together two of the foremost steel and rail producing firms in the country. That was effected about a couple of years ago, and since then both have been pushing on with extensions, particularly Steel, Peech and Tozers, whose headquarters are just over on the Rotherham side of the Sheffield boundary, but whose extensions at Templeborough are creeping into Sheffield. The present negotiations by which these concerns acquire a controlling interest in the Frodingham Iron and Steel Company is of chief importance in the sense that they ensure for the

firms an almost illimitable supply of Lincolnshire ore and other iron-making materials, in which the Frodingham district is very rich, besides which the Frodingham works have a large output of pig iron and of steel and possess fine rolling mills especially adaptable for girder and other constructional steel manufacture. The influence of this fusion of interests goes still further, inasmuch as it includes a half share in the Appleby Ironworks, a property which some few years back came into the joint possession of the Frodingham Iron and Steel Company and the Steel Company of Scotland.

After 1800 Years.

The Templeborough extensions to which I have referred are of particular interest. The site of these works was a Roman Camp, the splendidly preserved ruins of which have had to be cleared away. There were found substantial remains of a large encampment, including cavalry and infantry barracks, with stables, baths, guard houses, outer and inner defences, and so on, and a good drainage system to the river. But the most striking discovery was the plain evidences of the existence of an ironworks, made and used by the Roman legions for the manufacture of weapons, chariot fittings, structural work, &c. There are spoil heaps from which slag has been obtained, and, I believe, is at present under analysis with a view to discovering the source of the Romans' ore supplies. They were most probably found on the spot and accounted for the choice of that site as a permanent camp. Iron ore was long ago found in the neighbouring district of Kimberworth, and practically the same quarter saw the very beginnings of the iron trade of Yorks. It is a remarkable coincidence, therefore, that after an interval of nearly 2000 years an ironworks of the most modern description should be rising upon the very site used by the Romans for an ironworks which doubtless in their day embodied the very latest ideas and were the wonder and admiration of the ancient Britons.

American Visitors.

Since my previous letter a party of United States journalists, including representatives of the *New York Sun* and the *New York Tribune*, have spent a day in Sheffield as guests of Vickers. They came filled with enthusiasm about what America is already doing for the war. They went away impressed with the fact that America "has a good long way to go yet before she is as far 'in' as Sheffield." Mr. William Clark, one of the directors, with Mr. Skeggs, the chief engineer, and Colonel Turner, accompanied the party round the great works, and before the tour concluded the visitors were informed that they had walked altogether about 6½ miles. Several nice little things had been arranged for the occasion, two of the most interesting from the spectacular point of view being the tapping of a huge steel furnace and the rolling of an armour plate, the latter with its invariable pyrotechnic display. What the visitors saw must not be detailed in print, but it afforded them an excellent idea of what the Sheffield "bustle" means and, as one of them remarked, it would make them "dream of guns for nights."

Round the Works.

Besides the rolling mill extensions mentioned last week, further developments of a similar nature are on hand here, and as other steel districts are, from all accounts, experiencing the same sort of thing makers of rolling mills and accessories have a busy time in front of them. There is an enormous output of ingot moulds; and in the manufacture of tanks, such as are required for oil storage, great activity prevails. On the whole the steel position, so far as war material is concerned, is quite good, whilst the production is under constant expansion. It is possible that greater attention will have to be paid to the necessity for more blast-furnaces, which seem to be in danger of being curiously outstripped by the development of open-hearth steel furnaces. The two must, of course, move forward together. The demand for electric steel-melting furnaces in this district is as great as ever; but for some reason the Ministry of Munitions is making it difficult to obtain permits for erecting them. It is said that a number of Heroult furnaces are being installed notwithstanding this handicap, though why a freer hand cannot be given for the erection of electric furnaces generally it is hard to understand. Surely if ever they were wanted it is now! The ways of Government Departments are at times past finding out. I learn that one steel firm that has not hitherto done over-much in that direction is now diligently developing the edge tool side of its business. Before the war these people did a large business with Germany, and still have important South American connections, though a very considerable portion of their output is on home account for special steels. One still hears complaints of the serious tailing off of overseas business through the difficulty of securing export licences; but somehow or other a very tidy margin is maintained, though, of course, nothing like it might be. New business of this kind includes steel for Wellington, Lyttelton, Bahia, Winnebah, Toronto, Calcutta, and Madras; hardware for Puerto Cabello, Cartagena, and Calcutta; files for Monte Video, Buenos Aires, Rio, and Calcutta; electro-plate for Valparaiso, Yokohama, Santos, and Buenos Aires; saws for Penang, Porto Novo, Bombay, Cardenas (Cuba), and Santander; tools for Calcutta, Singapore, Penang, Bahia, Monte Video, Capetown, Rangoon, Kingston (Jamaica), Beira, Madras, and Shanghai; sheep shears for Montreal and Buenos Aires; shovels for Durban, and cutlery for Iquitos, Calcutta, Rio, Bahia, and Havana.

Iron, Steel, and Coal.

The position of the iron and steel markets locally remains much as reported in my letter last week, nor is any particular change expected at the moment. Practically everything is now pegged down to maximum rates, and markets are very firm upon these. All kinds of scrap are in strong request, but merchants are still a good deal in the mist regarding some parts of the latest Government regulations as to selling. Discard steel is much sought after, though the demand is having an adverse effect upon values from the buyers' point of view. There still seems little anxiety on the part of consumers of raw material to cover their requirements far ahead, there being an idea that the war may end abruptly before the winter, though, of course, the official maxima would presumably hold good for six months after the signing of peace. The steam coal market keeps strong and active, collieries being pressed for supplies, but shipments to France and Italy are not quite so large, though any falling off in that direction is made up by the requirements of the Government at ports. Slacks continue steady, and house coals are very strong for all qualities. Regarding the effect of the coal control, especially as to the large quantities of fuel required for the London district, there is a divergence of view amongst collieries and merchants; but generally sympathy is expressed with the Controller, who, it is realised, is doing his best to meet all the circumstances, and to guard against excessively heavy haulage to London during the wintry, foggy months. Best South Yorkshire steam hards quote 17s. 6d. to 18s.; best Derbyshire hards, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; cobbles, 16s. 6d. to 16s. 9d.; nuts, 16s. 6d. to 17s.; best hard slacks, 12s. 6d. to 12s. 9d.; seconds, 12s. to 12s. 3d.; soft nutty, 12s. to 12s. 3d.; peas, 10s. to 10s. 6d.; small slacks, 6s. to 6s. 6d. In house sorts branch quotes 21s. to 22s., and best Silkstone, 18s. to 19s. per ton at pits. Coke keeps very firm on maximum rates.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE conditions prevailing on the Cleveland pig iron market just now are of such a character as to leave very little margin for the development of any fresh feature of particular interest, or for any immediate substantial alteration in the general state of affairs. Supplies of all descriptions are taken up on such an extensive scale by the Control Committee that there is exceptionally little scope left for open market operations. This week the market has been very quiet, but firm. Buyers generally have covered their requirements under the September allocations, and are now chiefly concerned in securing regular deliveries under existing contracts. Unfortunately, a lack of railway trucks—which, it is hoped, is merely a temporary difficulty—coupled with the ever-present labour shortage, is tending to retard rail deliveries, although every effort is being made to overcome that difficulty. There is, at present, rather an excessive output of forge iron—a not unusual consequence of the holiday period—but, fortunately, Scottish consumers are in some cases willing to take forge iron, so that the amount going into stock is not excessive. The export trade is, of course, entirely limited to France and Italy, and as all French business is now conducted through official channels, merchants' export business is confined to shipments for Italy, which are on a fairly liberal scale just at the moment. The maximum home prices are unaltered at 96s. 6d. for No. 1, and 92s. 6d. for No. 3 Cleveland g.m.b., No. 4 foundry, and No. 4 forge. The export quotations are:—No. 1, 107s.6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

There is plenty of industrial activity in the hematite pig iron trade of this district. The demand for iron is very heavy all round, and there is no abatement of the pressure for deliveries. The needs of home consumers are being fairly and adequately met under the very careful allocation of the output by the Control Committee; but the present restricted output leaves little surplus for shipment to France and Italy. For both these countries there is, of course, an urgent demand, but it is to be feared that when the July and August licences are issued there will be a further reduction in the present limited monthly allocations. To compensate for this, it is reported that the Italians are already making inquiries for supplies from the United States. No official statement with regard to price has yet been made, but in the meantime the home maximum price for East Coast mixed numbers is 122s. 6d. per ton, and for export the price, subject to official sanction, is 141s. per ton, plus the excess ore freight above the agreed parity.

Iron-making Materials.

The improving tonnage situation has resulted in better business in foreign ore at the current official rates. Deliveries are coming to hand more freely than for some weeks past. The coke market is steady, and though prices are firm, consumers' needs are being fully met, good medium qualities being quoted 30s. 6d. per ton delivered at the works.

Iron and Steel Exports.

The exports of pig iron from the Cleveland district for the month of August show an increase of 6350 tons, as compared with the month of July, the aggregate being 59,083 tons for August, and 52,733 for July. Of the August shipments, 57,833 tons went abroad, as against 50,788 tons in July, while the coastwise shipments amounted to 1250 tons, which represents a drop of 695 tons. In July the exports of manufactured iron and steel amounted to 39,510 tons—2174 tons coastwise, and 23,477 tons abroad, or a total of 24,380 tons. The aggregate shipments of pig iron and manufactured iron and steel were 83,463 tons in August, 92,243 tons in July, and 81,390 tons in June.

Manufactured Iron and Steel.

There is no material change to report this week in the conditions prevailing in the manufactured iron and steel departments. All departments are kept oppressively busy. Even with the added output of steel of every grade, which has recently been made possible, the entire production is absorbed as rapidly as it is turned out. The constant and growing activity at the shipbuilding yards has greatly increased the necessity for steel considerably in excess of anything hitherto known in the trade, the programme instituted by the Shipping Controller being prosecuted with the most vigorous energy. There is, therefore, no diminution in the demand for the ship plates, angles and sections required. In the manufactured iron trade, the requirements for war purposes show no falling off, and in all departments the most intense activity prevails. The export trade in both sections is very quiet. Applications for licences are closely scrutinised, and none granted unless the material is essential in some way or other to national interests. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £11; packing iron, tapered, £11 15s. to £12 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ¾in. and upwards, £13 10s.; ⅝in., £13 15s.; ½in., £14; ⅜in., £16; ¼in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12, all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

As predicted would be the case, the Ministry of Munitions has withdrawn the maximum price of heavy wrought iron scrap fixed in March last, and issued fresh schedules for iron and steel scrap. The new maxima will get rid of some at least of the anomalies of the old arrangement; but it cannot be said that the dissatisfaction with regard to the prices has been altogether removed. As regards wrought iron scrap, limits of £5 5s. and £5 15s. had been fixed for material, much of which was worth a good deal more, with the result that holders refused to sell. For the future sellers of the kind of scrap referred to will be allowed to charge up to £6 5s., but many still contend that this is not high enough. Some discontent also exists with the arrangement respecting carriage. When delivered prices were fixed originally opposition was raised, and the subsequent alteration to f.o.t. terms does not work well. The former plan would certainly be more advantageous in encouraging deliveries of scrap to the works nearest the source, and thereby tend to economise railway haulage and the use of railway stock. Some changes are also made in the steel scrap schedule. Sellers may now accept up to £3 10s. for any kind of turnings or borings, provided that the material is not mixed with iron. Previously this limit applied only to the heaviest and best turnings, the remainder being limited to £2 10s. The latter figure now applies to mixed turnings.

The Coal Trade.

There is no pronounced change in the coal trade. While some merchants report some improvement in the situation generally, others are placed in an unsatisfactory position, owing to the unfortunate conditions over which they have no control. On the other hand, the consumption not only maintains the high level at which it has so long stood, but shows a tendency steadily and materially to increase. The collieries, however, are by no means working at high pressure. The disposal of orders by the local committees has slightly bettered the condition of the Northumberland pits, which for some weeks past have suffered from lack of ready trade. In Durham the pits are, on the whole, more favourably placed, though some collieries with a limited range of grades are not in such a position. Official requirements continue heavy, and the only dulness perceptible is apparently confined to the inferior grades which form a surplus, and are not considered so good value at schedule prices as the better class sorts. Neutrals are operating as freely as circumstances will permit, and any slackness is not caused by any falling off in the demand, inquiry being quite brisk. If transactions could be completed there would be no difficulty about the surplus or the accumulation of stocks, and a way out may yet be found either officially or unofficially. Best steams are still in good demand, and remain firm, while there is an improved undertone. All other qualities, including smalls, are plentiful at recent quotations. Smithies, peas, and nuts are fully taken up, practically nothing being available for export. The household coal trade is slow, and there are plentiful supplies. Coke has a good market, and with an increasing demand the output is well taken up. Quotations are as follows:—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade; 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 28s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

Big Developments on the Tees.

Important developments on the north bank of the Tees are foreshadowed. At a meeting of the Tees Conservancy Commission on Monday the general manager—Mr. J. H. Amos—announced that the terms and conditions of H.M. Commissioner of Woods, and the Tees Commissioners, in connection with the sale of the unsold reclaimed land at Haverton Hill had been accepted by Lord Furness. As the result of a recent actual survey the land has been found to contain 52 acres, with a river frontage of 1550 lineal feet. The site was required by Lord Furness for the purposes of a shipbuilding yard, dry docks, and engineering works, and berths would be laid down for the construction and launching of vessels of heavy tonnage. His Lordship's advisers were of opinion that the area of the plot of reclaimed land referred to was not sufficient for the purposes required, and after negotiations the general manager arranged for the sale to Lord Furness of a further site, the property of the Ecclesiastical Commissioners, of about 33 acres, and a frontage to the river of 940 lineal feet, immediately adjacent to the reclaimed land. The total area of land purchased by Lord Furness is therefore 85 acres, with a frontage to the river of 2490 lineal feet.

Speeding-up Shipbuilding.

To accelerate production in shipbuilding on the Tyne a committee of employers and men's representatives has been formed under the Admiralty Shipyard Labour Department. The principal object is to make full use of all available labour by a system of quick transfer of men from one shipyard to another.

SCOTLAND.

(From our own Correspondent.)

Glasgow Shipping Deal.

MESSRS. JAMES GARDINER AND CO., shipowners, Glasgow, have sold their fleet of steamers, consisting of fourteen cargo carrying vessels of an aggregate tonnage of about 70,000 tons gross. The buyers, it is understood, are Furness, Withy and Co. (Limited), Liverpool. The vessels, which range in measurement from 3537 to 5200 tons, are all of modern construction, the oldest having been only sixteen years in service. Messrs. Gardiner and Co. are an old-established Glasgow firm, and the present directorate includes Mr. F. C. Gardiner, who has done a considerable amount of valuable work for the Government in connection with shipping and transport business during the war.

Pig Iron.

Activities in the pig iron trade are fully maintained. The majority of the furnaces are now producing hematite, with a consequent shortage of other descriptions. Prices are all firm and unaltered, but there is practically nothing in the way of private trade being done with home consumers, while exports are confined to shipments to the Allies.

Quotations.

Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

All energies in the Scotch steel and iron trades are still concentrated on war requirements. Works everywhere are labouring under tremendous pressure, but in spite of all efforts to increase outputs the production is still inadequate. The shortage of imported raw and semi-manufactured materials has something to do with this state of affairs, but an improvement in this respect is anticipated. Apart from war work, the steel works are not accepting anything unless accompanied with a priority certificate, but the supply of these is greatly restricted. Black steel sheets, too, are hardly obtainable, and though the price remains about £18 5s. per ton, much higher prices would willingly be paid for guaranteed deliveries. The cost of galvanised material is still prohibitive, unless for use in connection with Government work. Malleable iron makers are also quite unable to supply their ordinary customers, including those who might be satisfied with a shell discard quality. "Crown" iron bars are quoted round about £15 15s. to £16 per ton for export, but this class of business is at a standstill, with the exception of Allied necessities. All classes of engineers report plenty of good profitable employment, while the pressure of work at the shipyards is as heavy as ever.

Coal.

The Scotch coal trade presents no new features. General conditions are unchanged, and the conduct of business is far from satisfactory. It is thought that, perhaps, the introduction of the new territorial distribution scheme may work some improvement, but in the meantime the situation is not encouraging. In the West of Scotland the industrial demand and a growing household turnover provide a certain amount of steady employment for the collieries, but in Fifeshire and the Lothians, where local requirements are quickly satisfied, the men are only getting from three to four days' work in the week. The aggregate shipments from Scottish ports during the past week amounted to 164,792 tons, compared with 185,851 in the preceding week, and 174,613 tons in the corresponding week of last year. Ell coal is quoted f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steam, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s.; first-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s.; best steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coals for Home Consumption.

DURING the past week colliery owners have been engaged very largely in making arrangements, as far as possible, to carry out their obligations in connection with supplying coals for home consumption, as provided under the scheme in connection with the Coal Transport Reorganisation Order. A number of questions has naturally arisen requiring elucidation, and what concerns many colliery undertakings to a very important extent is that relative to the wagon supply. As is well known, numerous collieries have only sufficient rolling stock to give them a three days' margin of work when engaged running from pit to port, and apart from their wagons being to some extent unsuitable for inland trade it is feared that, with wagons being used for inland purposes, and resulting in longer detention, they will more frequently be short of rolling stock, and consequently experience greater difficulty in maintaining regularity of work at the pits. In many cases collieries which have not previously supplied coals for inland use have notified purchasers, who, under the scheme of substitution of orders, have been referred to them, that they or the railway company must supply the wagons required to transport their coals. The Coal and Coke Supplies Committee, which has been making the arrangements to give effect to the Order, under the direction of the Controller of Coal Mines, has decided that the colliery companies are entitled to ask from the purchasers "cash with order" if they desire to adopt this course. The present system of payment is cash in seven days, but although under the new scheme colliery companies are compelled to supply the coals there is no guarantee regarding payment, and, inasmuch as they have had no business transactions previously with many of the purchasers, it is thought only right if colliery companies think it necessary that they should stipulate for cash with order. In a circular issued by Mr. Finlay A. Gibson, the secretary of the District Coal and Coke Supplies Committee, it is stated that South Wales is a coalfield which has a surplus only of steam and manufacturing coals, and insufficient supplies of house coals to meet the requirements of all the consumers in its own area. It will be impossible therefore for the Committee to arrange for the supply of house coal in the Southern counties, but the colliery companies have been requested to supply, as substitutes, coals of a bituminous nature approximating as nearly as possible to those used for household purposes.

The Housing Problem.

The housing problem is probably nowhere more acute than in South Wales. The question is receiving a good deal of attention, and when the conditions are more favourable building operations will, it is expected, be on a very large scale, particularly in districts where colliery developments are likely to take place. A proposal is now on foot to build between 250 and 300 houses for the working classes in the Bedwas and Machen areas, and the clerk to the District Council has been instructed to ask the various landowners what land is available, and the terms upon which it can be acquired.

Colliery Examiners Tender Notices.

The majority of the members of the South Wales and Monmouthshire Colliery Examiners' Association tendered on Saturday last a month's notice, in accordance with their previous decision, in support of their claims for uniform rates of pay and recognition of their association by the employers. In a number of cases in outlying districts, where the rule for examiners, as well as other colliery workmen, is a fortnight's notice, it is understood that notices will be tendered later, so that contracts shall terminate together. The membership of the association is about 4000, but the examiners engaged at the properties of the Powell Duffryn Company, the Ocean Coal Company, and Nixon's Navigation Company, and some others, are not members of it, and therefore are not taking part in the present course of action.

Proposed War Tax.

News was received recently by Cardiff shipowners that the Argentine Government proposes a new war tax upon all vessels visiting the Argentine ports. This tax will be 50 cents in gold, equal to about 2s., per net registered ton. Shipowners are somewhat perturbed, as the tax will press unduly on them, especially those whose vessels are running at Blue Book rates. Steps have been taken to draw the attention of the British authorities to the matter.

Current Business.

Operations on the coal market during the past week have been on an extremely restricted scale, for the pressure has eased off to a very substantial extent. The consequence is that the conditions have been very unsatisfactory. All that colliery companies could do was to work up to the limit of their resources in wagon supplies, and then suspend work temporarily until sufficient wagons were released to make a restart. The majority of the leading companies producing superior Admiralty coals have managed to get along, but undertakings in the Monmouthshire area have fared badly. The accumulation of stocks has not been so acute in the matter of large coals as in that of smalls. The small coal problem has for the past year or two been prominent, and still awaits solution. Some collieries have over 10,000 tons of smalls standing, thus continually forming a menace to regular work at the pits by keeping the rolling stock out of running. House coals, manufacturing descriptions, &c., have been in good demand. Patent fuel remains about 30s. to 32s. 6d., but there has been very little fresh inquiry. Makers, however, have sufficient contracts to execute to keep them going; but some of them have been rather handicapped by lack of ready tonnage. Coke has met with good request, the price being 47s. 6d. Pitwood has been rather restricted in supply; but difficulties with regard to wagons for discharging into have cropped up, and although quotations rule up to 61s., values are variable, and may range from 58s. to 61s. according to the circumstances prevailing.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 22s. 6d.; unwashed duff, 14s. to 18s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Western Valleys, 29s.; seconds Western Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, best, 23s. 6d.; through, seconds, 22s.; smalls, best, 19s.; smalls, seconds, 17s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas, 27s. 6d.; seconds, 26s. 6d.; patent fuel, 30s. to 32s. 6d.; coke, 47s. 6d.; pitwood, ex ship, 58s. to 61s.

LATER.

The coal trade continues very quiet, the governing conditions being unaltered, and collieries as a consequence losing time in many cases.

Industrial Unrest.

The report of the Commissioners for South Wales and Monmouthshire upon industrial unrest was referred to at a meeting of the Cardiff Chamber of Commerce on Wednesday, when Mr. T. E. Watson, the president, said some of the recommendations would have their warmest approval, but others would not commend themselves to the chamber. He particularly referred to the recommendation that a worker should not be liable to be dismissed except with the consent of his fellow workmen as well as of his employer. He contended that action on the lines of some of the recommendations would prove absolutely subversive of discipline. The antagonism between capital and labour was due to the erroneous and extravagant ideas held by workmen as to the division of the joint product of labour and capital, and if the actual facts were laid before the working classes a healthier state of affairs would result. If the present antagonism continued it would lead to the ruin of capital and labour. It was ultimately decided that a special meeting of the chamber should be called for Wednesday next to consider the report.

Newport.

Business has been in a stagnant condition. Stoppages have been fairly numerous, and there is no immediate prospect of improvement Schedule prices:—Steam coal: Best Newport Black Vein, large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s.; pitwood, ex ship, 59s. to 61s.

Swansea.

The tone of the anthracite market has maintained a fairly good standard. Tonnage arrivals have been on a satisfactory scale over the week end. Large anthracite has met with a good inquiry, and machine made descriptions have moved off well. Rubbly culm and duff have, however, been quiet, and very little fresh business has been arranged. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 8s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, through, 23s. 6d.; smalls, 17s. and 19s. Bituminous coal: No. 3 Rhondda large, 27s.; smalls, 24s.; patent fuel, 30s.

Tin-plates.

There is no change of any note in the tin-plate trade. Makers are well off for orders, and prices are very steady on the basis of the maximum rates fixed by the Ministry of Munitions. Supplies of tin-plates are scarce, stocks being very considerably reduced. Quotations: Tin-plates, I.C., 20 by 14 by 112 sheets of 108 lb., 30s.; block tin, £241 15s. per ton cash; £241 per ton three months; copper, £120 per ton cash; £119 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W. 1.

ORDERS

For the week by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Second-Lieut. P. Bowden.

Next for Duty.—Second-Lieut. E. A. Ullmann.

Monday, September 10th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class, 6.30. Recruits' Drill, 6.30.

Tuesday, September 11th.—Physical Drill and Bayonet Fighting.

Wednesday, September 12th.—Drill and Elementary Bridge Construction for No. 1 Company, Right Half Company.

Thursday, September 13th.—Drill and Elementary Bridge Construction for No. 2 Company, Right Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, September 14th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Saturday, September 15th.—Commandant's Parade for Route March and Drill. Parade Golders Green Station, 2.45 p.m. Uniform. "A" and "B" men are reminded that one Route March per month is compulsory. Recruits' Drill, 2.30.

Uniform.—"A" and "B" men are warned to attend headquarters on Tuesday, September 11th, to be measured by the regimental tailor for the service uniform.

Musketry.—All N.C.Os. and men who have signed the "A" and "B" agreements are required to attend during this month, to re-classify, in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be had at headquarters, and every enrolled man must obtain one without delay; at the same time, all old red armlets—now obsolete—must be returned.

Note.—Unless otherwise indicated, all drills will take place at headquarters.

By order,
MACLEOD YEARSLEY,
Captain and Adjutant.

September 8th, 1917.

FORTHCOMING ENGAGEMENTS.

TUESDAY, SEPTEMBER 11TH.

INSTITUTE OF MARINE ENGINEERS.—President's address. 7 p.m.

WEDNESDAY, SEPTEMBER 19TH.

INSTITUTE OF METALS.—Rooms of The Chemical Society, Burlington House, Piccadilly, W. 1. Annual autumn meeting. For programme see page 215. 4 p.m. and 8 p.m.

THURSDAY, SEPTEMBER 27TH.

ASSOCIATION OF RAILWAY COMPANIES' SIGNAL SUPERINTENDENTS AND SIGNAL ENGINEERS.—Railway Clearing House, London. Fifty-fifth Conference.

MINISTRY OF MUNITIONS ORDERS.

CRUDE BENZOL, CRUDE NAPHTHA AND LIGHT OILS.

THE Minister of Munitions, on the 29th ult., issued an Order relating to the above in the following terms :—

1. No person shall as from October 1st, 1917, until further notice, supply to any person or take or accept or attempt to obtain delivery of any crude benzol, crude naphtha or light oils containing recoverable quantities of benzol or toluol, except under and in accordance with the terms and conditions of a license issued by or under the authority of the Minister of Munitions, or under and in accordance with the terms and conditions of a contract in writing for the delivery of such articles existing at the date of this Order.

2. All persons engaged in producing, treating, distributing, storing, selling, or dealing in crude benzol, crude naphtha, or light oils, or in any manufacture, trade, or business in which the same or any of them are used, shall make all such returns with regard to their businesses as may from time to time be required by or under the authority of the Minister of Munitions.

3. For all purposes of this Order the following expressions shall have the following meanings :—"Crude benzol" and "crude naphtha" shall mean crude benzol and crude naphtha obtained by distillation of coal tar or extracted from coal gas, including benzolised wash-oil before separation of the crude benzol. "Light oils" shall mean light oils obtained by the distillation of coal tar.

NOTE.—All applications in reference to this Order, including applications for licenses, should be addressed to the Director of Raw Materials Supply, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, S.W. 1.

CHROME ORE.

ON the 31st ult., the Minister issued another Order under which no person shall as from the date mentioned, until further notice, purchase or take delivery of chrome ore of any grade except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions. It is further stipulated that no person shall as from the same date, until further notice, sell, supply, or deliver chrome ore of any grade except to the holder, and, in accordance with the terms of such a permit, to purchase or take delivery as aforesaid.

NOTE.—All applications for a permit in connection with the above Order should be addressed to the Director of Materials, reference AM2/FWH, Ministry of Munitions, Hotel Victoria, Northumberland-avenue, W.C. 2.

LEAD.

A LENGTHY Order relating to lead was issued by the Ministry of Munitions under the date September 1st. Under this Order the Minister takes possession as from the date named until further notice of all pig lead, whether virgin or remelted, old and scrap lead, and lead residues now or hereafter situated in the United Kingdom, subject to certain specified exceptions. The lead of which possession is taken will, until further notice, be paid for by the Minister of Munitions on delivery, as to virgin pig lead at the prices specified below, and as to remelted, old and scrap lead, and lead residues, upon terms which will be communicated in due course to the various owners. All existing licences for dealing in any remelted, old or scrap lead, or lead residues, are cancelled by the Order, while no person is now allowed to purchase or sell lead situated outside or in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions. There are certain exceptions to this clause.

No purchase or sale of lead situated in the United Kingdom shall, in the case of any class of lead specified in the following schedule, until further notice, be at a price exceeding the price set opposite the same in the schedule. Restrictions are imposed as to the use of lead, and returns are required each month as to all lead held in stock on the last day of the preceding month, and so on in the usual way.

Schedule Maximum Prices.—Virgin Pig Lead : £29 per ton c.i.f.; £30 per ton ex store or ex refiners' works. Manufactured Lead : Sheet lead, £39 10s. per ton, delivered United Kingdom, less 2½ per cent. monthly account, the usual trade extras and allowance to apply ; lead pipe, £40 per ton.

Lead Compounds.—Dry White Lead, £46 per ton, less 5 per cent. monthly account, delivered United Kingdom. The usual trade extras and allowances to apply. White Lead in Oil, £53 per ton, less 5 per cent. monthly account, for deliveries in packages of 5 cwt. and over ; £55 per ton less 5 per cent. monthly account for lots of less than 5 cwt. White lead in packages less than 5 cwt. to be charged at the customary trade extra for packing. Red Lead and Litharge, £42 per ton, less 2½ per cent. monthly account, in 5 cwt. casks delivered United Kingdom. The usual trade extras and allowances to apply.

COAL TAR.

THE Minister of Munitions has decreed that from October 1st, until further notice, no person shall, unless he be a tar distiller, purchase or offer to purchase any coal tar (whether crude or dehydrated), save in small quantities, except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions.

THE Railroads' War Board of the United States has addressed a plea to public authorities urging co-operation with the railroads in a suspension during the war of all efforts not designed to help directly in the winning of the war. The appeal says that the present emergency has imposed upon the railroads a very severe strain in transporting men, food, coal, munitions, and materials in augmented quantity. This burden, while cheerfully undertaken, requires every ounce of energy, every unit of rolling-stock, every dollar of capital, every bit of supplies and coal which the railroads can command. The erection of new stations and the elimination of grade crossings are suggested as non-essential works.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

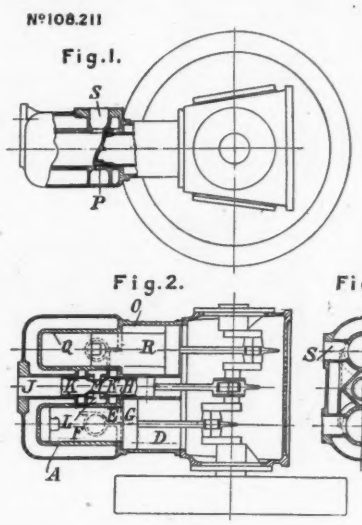
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application ; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

108,211 (11,011 of 1916). August 4th, 1916.—SINGLE-ACTING TWO-CYCLE ENGINES, John Davidson, 48, Park-road, Pendleton, Manchester.

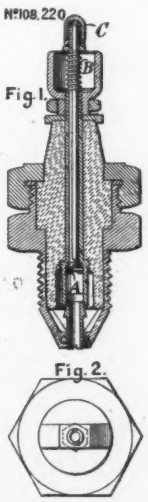
THIS is a two-stroke engine with a piston valve driven directly from an excentric fixed on the crank shaft of the engine to control the distribution of the working mixture to and from the charging cylinders. Drawings are given in Figs. 1–3. As the charging piston G moves outwards, the valve H is also moving in the same direction, and by means of the slots K and port E puts the charging cylinder D in communication with the mixture inlet J and allows a charge to be drawn in. Upon the return stroke, the valve H first cuts off communication with the inlet J, and afterwards makes communication between the charging cylinder D and the receiver space L, by means of the annular space around the valve H at M. As the charging piston moves



inwards the charge is slightly compressed into the receiver space L. In a similar manner the mixture is admitted to the charging cylinder O by means of slots K^1 in the valve H, and on the return stroke the annular space M of the valve H makes communication between the charging pump O and the receiver space L. The inlet ports B P of the working cylinders A Q open into the receiver space L. It will thus be seen that when the charging piston R is nearing the end of its inward stroke the working piston G has uncovered the exhaust port S, allowing the gases in Q to escape, and the inlet port P will just be opening to allow the mixture in the receiver L to enter the cylinder Q. Upon the return stroke of the piston R the inlet port P is closed, the charge compressed and fired in the well-known manner.—*August 2nd*, 1917.

108,220 (11,982 of 1916). August 23rd, 1916.—SPARKING PLUGS, John Jelliff Platt, Milford, New Haven, Connecticut, U.S.A.

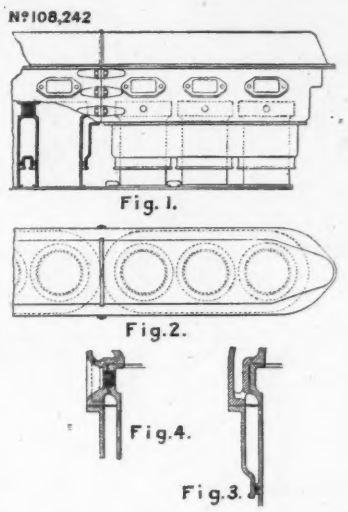
The object of this invention is to provide a reliable and economically combined self-cleaning and priming sparking plug. Figs. 1–2 show the construction of such a plug, from which it will be seen that there is a tubular electrode, which communicates with the exterior of the plug upon the outside of the engine. The bore of the tubular electrode contains a stem which is movable therein, and which provides for opening the bore to admit of the passage of the priming liquid and air. Under



ordinary conditions the bore of the tubular electrodes is maintained in a closed condition by the valve A and its spring B. By pushing inwardly on the cap C the valve is opened, thus permitting any priming liquid to be introduced to the cylinder, and also permitting cleaning or decarbonising liquid to be introduced therein. The opening also permits carbon to be blown out through the plug in the usual carbon cleaning processes. It will be observed that the working parts referred to are contained within the plug, and therefore are protected from injury, the device of this invention being therefore self-contained. When the valve is pushed inwardly it comes in contact with the opposing electrodes and prevents any spark.—*August 2nd*, 1917.

108,242 (14,482 of 1916).—WATER JACKET FOR MULTI-CYLINDER ENGINES, Wolseley Motors, Limited, Adderley Park, Birmingham, and others.

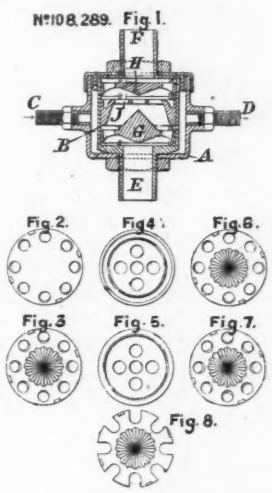
This invention relates to multi-cylinder engines, in which independent cylinders formed with integral heads are fixed to a common cooling jacket, and in which the cooling water is in direct contact with the portions of the cylinders within which the pistons travel. The portion of the jacket which surrounds the cylinders within which the pistons travel is constituted as a separate and removable skirt. A suitable fluid-tight joint is made between the lower end of the skirt and the cylinders to prevent leakage. In the case of an engine having four or more



cylinders, the cylinders may be arranged in groups of two or more in each group, of which the cylinders of each group are fixed within a separately formed section of jacket, these sections being bolted together to form a rigid structure. Fig. 1 shows, in elevation, a group of three cylinders which are fixed to a section of water jacket, which is itself fixed at one end to a water jacket of a second group of cylinders, a portion of which only is shown ; Fig. 2 is a plan view of the arrangement shown by Fig. 1 ; Fig. 3 is a section through one side of a cylinder and water jacket, to an enlarged scale, the upper portion of the water jacket being broken away ; and Fig. 4 is a section, to the same scale as Fig. 3, showing provision for fitting a sparking plug in place.—*August 2nd*, 1917.

108,289 (5561 of 1917). April 20th, 1917.—VAPORISER, John Lepine Hanman, 12, Dorset-square, London, N.W. 1.

This apparatus—Fig. 1—comprises inner and outer parts A, B which are secured together, as shown. The outer chamber has two branches C, D for the passage of hot air or exhaust gases, and the inner chamber branches E F for the admission of fuel



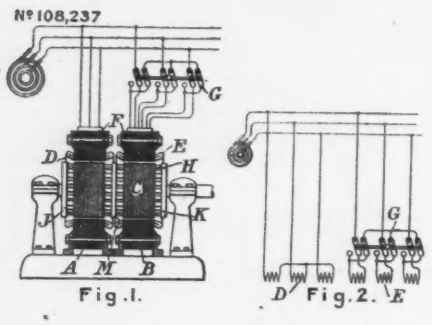
and its passage to the engine after impinging on the baffle plates G, H, J. The construction of the baffle or atomising plates is shown in the illustrations Figs. 2–8. The plate or cone J has on its upper surface a circular groove to collect a small amount of the fuel to facilitate the starting of the engine.—*August 2nd*, 1917.

DYNAMOS AND MOTORS.

108,237 (13,803 of 1916). September 28th, 1916.—ELECTRIC MOTOR CONTROL, *British Thomson-Houston Co., Limited*, 83, *Cannon-street, London, E.C.* (a communication from the General Electric Company, Schenectady, New York).

In this system of electric motor control an induction motor, having two primary windings, is connected to a source of supply associated with a two-part secondary winding, whose parts are electrically interconnected and shunted by a high resistance. Means are provided for reversing the connections between one of the primary windings, and the source to reverse the phase of the voltage applied thereto. Fig. 1 shows a motor of the type described connected to a source of supply in accordance with the invention, and Fig. 2 is a diagram showing the connections obtained by means of the switch shown in Fig. 1, the secondary winding being omitted. A motor of the type indicated will ordinarily be constructed with two stator members A and B, arranged to co-operate with a rotor C. The primary windings of the motor will commonly be mounted upon the stator, and are shown at D and E, provision being made, by means of terminal boards F, for the connection of the primary windings D. E and the source of supply. There is arranged a double-throw switch G, by means of which the connection of the phases of the primary winding E to the source of supply may be reversed. This change in connections will be readily seen by reference to Fig. 2, wherein are illustrated the primary windings of a three-phase motor of this type. The equivalent connections for any other number of phases will readily suggest themselves to one skilled in the art.

As illustrated in Fig. 1, the secondary winding H upon the rotor may be constructed as a squirrel-cage winding provided with end rings J and K, the two parts of the winding being electrically

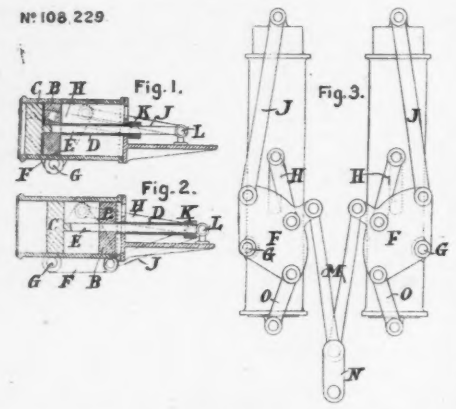


interconnected, and having their interconnections shunted by a high resistance, which, in this instance, is constructed as an intermediate high resistance ring M.—*August 2nd*, 1917.

PUMPING AND BLOWING MACHINERY.

108,229 (13,050 of 1916). September 14th, 1916.—PUMPS AND AIR COMPRESSORS, John Holloway, 15, Westland Drive, Whiteinch, Glasgow.

This invention is for a compressor or pump having pistons differentially movable in the same direction between which pistons the medium is compressed or forced, and actuating mechanism comprising an oscillating element, to spaced points of which are taken connections to the pistons, the arrangement being such that the pressures on the pistons are about equal, and the pistons balanced when the pressure between them is at its maximum. The piston B is connected to a hollow piston-rod D, through which passes the piston-rod E of the piston C. F denotes one of two oscillatory quadrants fulcrumed at G, to angularly spaced points of which are connected links H and J, connected in turn to crossheads K and L, connected respectively to the piston-rods D and E. In Fig. 1 the pistons are shown at the

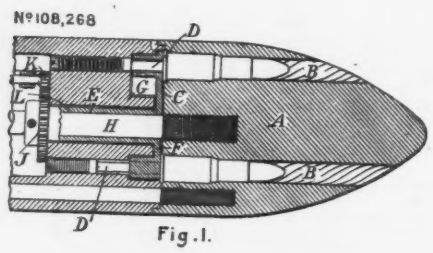


end of the working stroke. In the suction stroke the quadrant F rocks to the position shown in Fig. 2, the pistons gradually separating to the extent of the effective working stroke of the compressor or pump. When in Fig. 2 position the pistons are unbalanced, this unbalanced condition being reached when the load on the pistons is a minimum. In the working stroke the quadrant will return to Fig. 1 position, the piston B gradually overtaking the piston C, so as to compress the air, gas, or fluid through suitable valves. Fig. 3 shows driving mechanism for actuating twin double-acting compressors or pumps. As indicated, F denotes quadrants fulcrumed at G, and disconnectibly connected by means of links M with an oscillatory crank N, the quadrants having link connections H, J and O with the respective pistons.—*August 2nd*, 1917.

ORDNANCE AND ARMOUR.

108,268 (776 of 1917). January 16th, 1917.—ANTI-AIRCRAFT SHELL, Andrew Walter Graham, 184, Northland-avenue, Buffalo, Erie, New York.

The object of this invention is to provide an improved form of projectile which will discharge a volley of bullets when it has



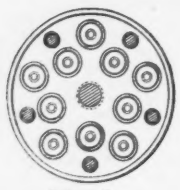


Fig. 2.

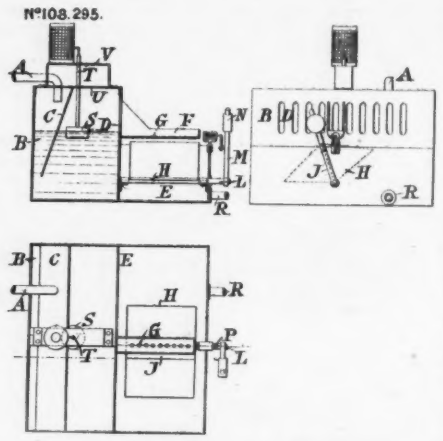
Fig. 3.

reached a certain height, the bullets being directed towards the object instead of being scattered indiscriminately, as with shrapnel. The shell is shown in section in Figs. 1—3, from which it will be seen that the forward portion A is provided with a series of cartridge receiving openings B. It has also a hollow base C, and a series of spring-pressed firing pins D mounted in the base, as well as means for holding the pins retracted, but which can move and release the successive pins. The latter comprises a sleeve E which carries the disc F having projections G. In order to effect movement of the disc F there is provided a shaft H which has its forward end screwed firmly into the nose portion of the projectile, and on this shaft is mounted a gear J which is fixed to the sleeve. Meshing with this gear J is a gear K which is carried by a drive shaft L. This drive shaft is connected to any suitable timing mechanism, which forms no part in its specific construction of the present invention.—*August 2nd*, 1917.

MEASURING AND TESTING INSTRUMENTS.

108,295 (6486 of 1917).—LIQUID METER, James Wilson, Ferrier Works, Fairfield-street, Wandsworth, London.

In this meter liquid is delivered through an inlet pipe A into a tank B having in it a baffle plate C. In the side of the tank B is a number of parallel slots D, through nine of which the liquid flows, when it has risen sufficiently high in the tank B, into another tank E. The liquid from the remaining slot is separated from that flowing through the rest of the slots by a trough F having perforations G. Below the perforated part of the trough G is a bucket H, divided into two equal parts by a partition J, and mounted upon knife-edge bearings. Secured to the axis

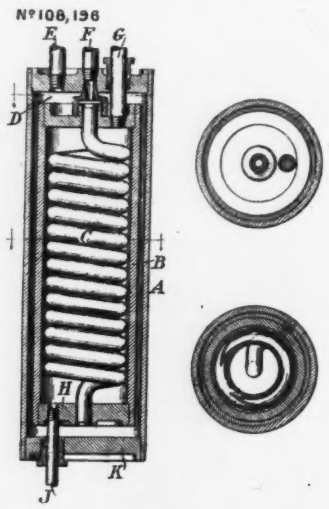


I, of the bucket H, by an arm M, is a balance weight N, and upon the arm is a projection which, as the bucket oscillates, moves an arm P which actuates a counter. The liquid from the bucket is delivered into the tank E, and passes with the rest of the liquid through an outlet R. In the tank B is a float S at the end of a stem T which passes through plates U and V. Upon the end of the stem is a recording needle which indicates the head of the liquid in the tank B upon a clockwork driven drum. Not only is the volume of liquid flowing through the meter recorded, but it can also be ascertained whether the flow is regular.—*August 2nd*, 1917.

MISCELLANEOUS.

108,196 (10,623 of 1916). July 27th, 1916.—REFRIGERATING MACHINES, Benjamin Seward McClellan, 564, West Adams-street, Chicago, U.S.A.

This invention relates especially to improvements in condensing apparatus for refrigerant systems in which ammonia gas is used. The improvement comprises in combination outer and inner casings A B forming a circulating chamber, a coiled conduit C enclosed in the inner casing, the conduit communicating at one end with the water supply, and at the other with the

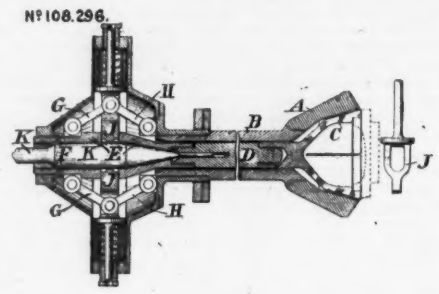


circulating chamber. The circulating chamber has a head D carrying the water discharge pipe E, the water supply pipe F, and an inlet pipe G for conducting a refrigerating fluid to be condensed to the inner casing, and a base H carrying a discharge pipe J for the condensed refrigerant, the discharge pipe passing through the base K of the circulating chamber.—*July 27th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

108,296 (7219 of 1917). August 23rd, 1917.—CHUCKS FOR MILLING MACHINES, Sydney White, 35, Gillingham-street, London, S.W., and another.

This is an improved clutch or chuck for the rotary spindles of milling machines, and consists of an outer conical member A, fixed to a rotary machine spindle B, and a similar cup-like part C that is split to allow it to contract when drawn within the part A, in order to grip the article to be machined. For drawing the member C within the outer part, the former is fixed on one end of a rod D mounted to slide within the hollow spindle B, to the other end of which is fixed a short tubular member E, on which is a ring F. To this are pivoted links G of a toggle arrangement, other links H of which are pivoted to the corresponding end of the spindle B. The pivots of the links of the toggle arrangement are carried by blocks J that are constantly pressed by strong springs in a direction to force the clutching member C into the outer member A, so as to effect a grip on the work. The blocks J have extensions adapted to ride on the surface of an adjustable fixed pin K formed with a tapered end, the arrangement being such that when the extensions are on the body of the fixed pin



the toggle links are maintained against the action of the springs in a position such as to free the work holding clutch. As the spindle B is moved with the work toward the tool the extensions ride down the tapered end of the fixed pin and allow the toggle arrangement under action of the springs to come into action, whereby the work holding clutch is caused firmly to grip the work.—*August 2nd*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On one of the patents mentioned below £18 and on each of the remainder £26 have been paid in renewal fees.

No. 26,415/10.—Detinning scrap. In detinning scrap compressed bundles are washed, dried, and chlorinated in one and the same vessel. The bundles or packets are piled up in closed vessels, and the washing liquid is forced or drawn through repeatedly. Drying and chlorination are effected subsequently. Linde, C., Germany. Dated November 15th, 1909.

No. 26,747/10.—Vapour electric apparatus. Joints between containers and leading-in conductors for heavy loads are rendered gas-tight by mercury seals in conjunction with packings of leather, asbestos, rubber, or the like. Hartmann and Braun Akt.-Ges., Germany. Dated December 1st, 1909.

No. 26,835/10.—Lead oxide. In the manufacture of lead oxide from metallic lead, the oxidising-pot in which the melted lead is subjected to the action of superheated steam and air is made considerably longer than wide so as to provide a large free oxidising space in which there are no surfaces upon which crusts of lead oxide can form, and the stirring device can therefore be driven at a higher speed. The lead is fed in smaller quantities and at shorter intervals than usual. With this improved pot a vertical uptake is unnecessary, and it is sufficient to provide an upwardly inclined exit pipe. Bergmann and Simons Ges., and Lindgens and Sohne, Germany. Dated December 11th, 1909.

No. 26,936/10.—Embroidery machines. In embroidery machines, alternatively acting stitch-forming devices and auxiliary implements are controlled by the same jacquard device, the connection of the controlling device with the stitch-forming devices being such that the operation of changing over from the stitch-forming to the use of the auxiliary implements transfers the control from the former to the latter. "Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich) Akt.-Ges.," Germany. Dated November 20th, 1909.

No. 26,937/10.—Embroidery machines. In an automatic embroidery machine, the jacquard needle which controls the cord-laying devices also controls the scallop mechanism when the machine is running at the low speed. Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich) Akt.-Ges., Germany. Dated November 20th, 1909.

No. 26,938/10.—Embroidery machines. In a jacquard mechanism for embroidery machines, a stop motion is brought into action if more than one lifting-bar is operated, and simultaneously a returning mechanism is operated to bring back the lifting-bars. Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich, Akt.-Ges., Germany. Dated November 20th, 1909.

No. 26,939/10.—Embroidery machines. Relates to a safety device for jacquards. Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich) Akt.-Ges., Germany. Dated November 20th, 1909.

No. 26,944/10.—Embroidery machines. In a jacquard embroidering machine the stitch movement of the embroidery frame is determined by means of an adjustable connection. Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich) Akt.-Ges., Germany. Dated November 20th, 1909.

No. 26,945/10.—Cams. Relates to means for operating an oscillatory lever of the kind in which a pair of co-axial rollers carried by the lever engage separate driving surfaces formed on a single integral excentric member, one surface acting externally upon one roller, the other acting internally upon the other roller. Vogtlandische Maschinen-Fabrik (vorm J. C. and H. Dietrich) Akt.-Ges., Germany. Dated November 20th, 1909.

No. 27,600/10.—Obtaining copper from waste liquors. Cuprous oxide and copper suspended in the washing waters obtained in the manufacture of artificial cellulose products from cuprammonia, cellulose solutions are caused to settle by the addition of a colloid, such as starch. For example, the liquor may be that obtained by absorbing ammonia in the waters obtained by washing cellulose precipitated by alkaline reagents, and from which the ammonia has been removed by treatment with steam. The hot liquor is treated with starch made into a milk with cold water and the treated liquor run into a number of pits, in the first of which the magma containing the oxide separates. The cuprous oxide may be converted by igniting into cupric oxide for re-use in the process. Vereinigte Glanzstoff-Fabriken Akt.-Ges., Germany. Dated June 18th, 1910.

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VOL. CXXIV.—No. 3220] LONDON: FRIDAY EVENING, SEPTEMBER 14, 1917. [PRICE EIGHTPENCE BY INLAND POST TENPENCE

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SCHOOL OF TECHNOLOGY

UNIVERSITY OF MANCHESTER
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The Polytechnic, Regent-street, W.

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682 1 T. THORP, Secretary.

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R. H. WALPOLE,
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708 1

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For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c. 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground street, London S.E. Telephone No. 978 Hop. 822 G

For Immediate Sale, 600 H.P. VERTICAL QUADRUPLE-EXPANSION ENGINE, by J. Musgrave and Sons, Bolton; steam pressure 200 lb.—Full particulars from J. BIBBY and SONS, Waterloo-road, Liverpool. 441 G

For Sale, Blower, 5in., with ring oiling bearings, fast and loose pulleys; for immediate DISPOSAL.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth, Glos. 1703 G

For Sale:— Horizontal BORING, DRILLING and TAPPING MACHINE, 5in. spindle, with 36in. travel. Horizontal BORING MACHINE, 5in. spindle, with 33in. travel. Horizontal BORING, FACING and SCREWING MACHINE, by Sharp, Stewart and Co. Powerful RADIAL DRILLING MACHINE, 4in. spindle, 9ft. 6in. arm, 5ft. rise on column; the head angles for drilling to any desired angle. One Special DUPLEX PLANING MACHINE, by Hulse, suitable for planing switches and crossings two at a time. Two Lang's BORING and FACING LATHES, to swing 24in. diameter. One PLANING MACHINE, to plane 7ft. by 2ft. 6in. by 2ft. 10in. RIDDEL and CO., 40, St. Enoch-square, Glasgow. 695 G

For Sale:— One Horizontal Crossley GAS ENGINE, giving 12 effective horse power at 250 r.p.m. Size of pulley 54in. diameter. Complete with hand rails, magneto ignition, gas bag, and accessories. One shunt-wound E.C.C. GENERATOR, giving 120 ampères, 100-140 volts at 940 r.p.m. Pulley 13½in. diameter. On sliding rails with three bearings and massive fly-wheel. One Vertical three-cylinder GAS ENGINE, by Weyman and Co., giving 15 horse power, 200 r.p.m., with fly-wheel 54in. diameter. All to be seen near Warwick. Address, 727, "The Engineer" Office. 727 G

For Sale:— One 200 H.P. Triple-expansion, Single-acting High-speed Willans' ENGINE with extended side-plate for carrying dynamo. Must be removed. Price, £100 cash, to quick buyer. RIDDEL and CO., 40, St. Enoch-square, Glasgow. 697 G

For Sale:—

45 RIVETED STEEL GIRDERS, 2ft. high, 9in. on flange, 26ft. 8in. long, two ribs in middle, ¾in. plate top and bottom, ⅜ plate centre, three plates at bottom.

15 RIVETED STEEL GIRDERS, 22in. high, 9in. on flange, 26ft. 10in. long.

2 TANKS, 8 × 6 × 4.

2 CYLINDERS. Steel, fitted with tubes, 12ft. 6in. × 3ft. 6in.

18 ROOF SPANS, in new condition, 18in. high in centre, 3ft. 1in. ends, 27ft. long, made of two 6 × 3 channels, and braced by 3 × 2 steel angles.

All price £12 per ton, delivered free to works or f.o.r. London. Apply—C. A. ROBINSON AND CO., Anchor Iron Wharf, East Greenwich, London, S.E. 607 G

For Sale:— 350 K.W. ALTERNATOR, three-phase, 50 cycles, 550 volts, by B.T.H. Co., driven by 600 I.H.P. Cross-compound Engines by Barclay, 26in. H.P. cyl., 40in. L.P. cyl., 4ft. stroke, fly-wheel 20ft. diam., &c. &c. Very fine set.

ONE 125 K.W. ALTERNATOR, by Ferranti, Ltd., 2000 volts, 50 periods. Vertical Cross Compound Engine, 250 H.P., by J. and H. McLaren.

250 H.P. VERTICAL CROSS COMPOUND CONDENSING ENGINE, by J. and H. McLaren; Surface Condenser, Pumps, &c.

MIRRLEES-WATSON CONDENSER, with Separator, but without pumps; 30,000 steam per hour; 3000 sq. ft. cooling surface.

PAIR CROSS COMPOUND ENGINES, 600 H.P., 26in. h.p. cyl., 40in. l.p. cyl., 4ft. stroke, Corliss valves to h.p. cyl., slide valve to l.p. cyl., fly-wheel 20ft. dia., by Barclay, Sons and Co., Ltd.

CROSS COMPOUND HORIZONTAL ENGINE, 14in. h.p. cyl., 22½in. l.p. cyl., 32in. stroke, 12ft. dia. fly-wheel, by Davy, Paxman and Co.

STEAM-DRIVEN STRAIGHT-LINE AIR COMPRESSOR, by Holman; capacity about 1000 cub. ft. per min.; steam and air cylinders 18in. dia. by 2ft. 6in. stroke.

ONE DITTO, by Markhams; capacity 300 cub. ft. per min.

R. H. LONGBOTHAM & CO., Ltd., WAKEFIELD, & AT MILBURN HOUSE, NEWCASTLE-ON-TYNE. Tel.: 44 Wakefield; 867 Newcastle. Tel. Add.: "Engineer, Wakefield." 2017 G

For Sale, Electric Furnace Plant, consisting of:—One 600 H.P. Motor, 2 phase, 4 wire, 2000 volts, 50 periods, 730 revs.; one 405 K.W. Generator, 110 volts, single phase, 25 periods, 730 revs.; one Exciter, 25-19 volts, 235-175 amps., 730 revs.; also Starting Gear. Will consider sale of Motor or Generator separately. Bargain. BURY ELECTRICAL PLANT CO., Ltd., Castle Grounds, Bury. 661 G 'Grams: "Electric, Bury." 'Phone: 676.

For Sale, Electric Light Engine, compound cylinders 6½ × 11½, piston valve, fly-wheel governors, balanced crank, by Sissons, Gloucester.—Apply, A. DODMAN and CO., Ltd., Kings Lynn. 683 G

For Sale, Four Sets of Standard Type (Style 5) Babcock and Wilcox pattern improved MECHANICAL CHAIN GRATE STOKERS. Each set suitable for land type boilers on 6000 square feet of heating surface and 20,000 lb. of evaporation per hour when dealing with ordinary slack coal; fitted with 4-speed gear and the usual accessories. These are in good working order, and are at present on regular service load. R. H. LONGBOTHAM AND CO., LTD., Wakefield. 717 G

For Sale or Hire, Electric MOTORS, from 6 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-Street, London, E.C. Tel.: City 3932. 2025 G

For Sale, Siemens Direct-current compound-wound GENERATOR, 220 volts, 908 amps., to run at 200 revs. This has one bearing only, and is arranged to couple direct on to the engine shaft. 400 lb. Morgan oil-fired TILTING FURNACE, suitable for brass, aluminium, &c.; nearly new.—Write, LAKE and ELLIOT, Ltd., Albion Works, Braintree, Essex. 689 G

For Sale, Three Belliss-Green- WOOD-BATLEY STEAM SETS, each 187 K.W., 220 volts, 850 amps., 300 revs., consisting of Compound Vertical Engine, 160 lb. steam, superheat fittings, coupled multipolar generator, two shunt wound, one compound, combination beds; complete running order. Also complete Switchboard, suitable for above; three Generator Panels, and one ten-way Feeder Panel.—Address, 687, "The Engineer" Office. 687 G

For Sale, Two Sets of Three-throw PUMPS, 5in. × 9in. stroke; and One FORCE PUMP, 3in. × 4in. stroke. Second-hand, and in good working order.—Apply, SECRETARY, Infant Orphan Asylum, Wanstead, Essex. P995 G

For Sale, 20 Triple-pole Oil SWITCHES, from 25 to 100 amps., 400-500 volts, 50 periods, Ferranti's make. BURY ELECTRICAL PLANT CO., Ltd., Castle Grounds, Bury. 662 G 'Grams: "Electric, Bury." 'Phone: 676

Four "B" Type Mechanical STOKERS, by the Undersigned Co., for 3ft. diameter furnaces, complete with closed ashpits for forced draught, shafting, pulleys, and the necessary brackets for carrying same, also numerous spare parts. Two Babcock and Wilcox WATER-TUBE BOILERS; evaporative capacity, 7000 lb. of water per hour; heating surface 3010 sq. ft. each; complete with Crosthwaite furnaces and superheaters; insured 160 lb. steam. All above ex Power Station, in excellent condition and available immediate delivery, WESTERN ENGINEERING COMPANY, Swansea. 19 G

Steam Hammers:

Massive 3-Ton FORGING HAMMER, by Thwaites, new.	
3-Ton " second hand.	
15 Cwt. SINGLE STANDARD HAMMER, by Massey	£220
5 Cwt. " " " " "	£80
2 Cwt. " " " " "	£45
One AERIAL ROPEWAY, by Bullivant, 500 yards long	£600

Barges and Lifeboat:

Two 80-Ton STEEL BARGES, each	£375
Very fine TEAK LIFEBOAT, 35ft. 6in. long, 8ft. beam, with launching carriage, price	£90

JOHN FREDERICK WAKE, DARLINGTON. 711 G

Machine Tools:

Very fine Horizontal BORING, DRILLING and TAPPING MACHINE, by Muir, bed 26ft. long, two spindles 5in. and 2¼in. diameter, weight about 25 Tons, price	£750
Double-headed Horizontal BORING MACHINE, spindles 4¼in. diameter, weight about 16 tons, table 14ft. × 11ft. 6in.	£400
Treble-geared LATHE HEADSTOCK, 36in. centres, with 6ft. chuckplate, by Greenwood and Batley	£100
Two 16in. CENTRE LATHES.	
One double-headed MILLING MACHINE, by Smith and Coventry.	712 G

JOHN FREDERICK WAKE, DARLINGTON.

Cranes:

STEAM CRANES.

5-Ton STEAM LOCO. CRANE, by Stothert and Pitt, all motions	£600
3-Ton STEAM LOCO. CRANE, by Taylor and Hubbard, all motions	£220

DERRICK CRANES.

5-Ton DERRICK CRANE, by Morgan, 50ft. Jib	£250
5-Ton " " by " 45ft. Jib	£250

ELECTRIC CRANES.

5-Ton ELECTRIC LOCO. CRANE, Rushworth, as new	£700
30-Ton OVERHEAD CRANE, 3 motors, 50ft. span	£750
Two 20-Ton Hand-operated TRAVELLING GOLIATH CRANES, 40ft. span, good condition each	£300

STEAM NAVVIES.

Very Fine 12-Ton WHITTAKER NAVVY, almost as new, robuilt and ready	£1400
Two 12-Ton Wilson Crane Type NAVVIES, being rebuilt each	£1250
10-Ton Whittaker Crane Type STEAM NAVVY	£900
10-Ton Wilson "	£950
Modern 10 H.P. Ruston-Proctor Tower Type NAVVY, fine machine	£750
10 H.P. Ruston-Proctor Tower Type NAVVY	£500

JOHN FREDERICK WAKE, DARLINGTON. 713 G

Locomotives:

Two Eight-wheeled Four-coupled, 2-4-2, side tank, main line LOCOS., 17in. cylinders, being rebuilt each	£2500
13in. Four-coupled Hudswell-Clarke LOCO., 140 lb. w.p.	£950
11in. Six-coupled Manning LOCOMOTIVE, 140 lb. w.p.	£750
11in. Four-coupled Barclay LOCOMOTIVE, new box, retubed	£750
9in. Four-coupled LOCO., 120 lb. w.p.	£450
8in. Four-coupled Manning-Wardle LOCOMOTIVE	£500

NARROW GAUGE LOCOMOTIVES.

3ft. gauge, 10in. cylr. Hudswell-Clarke LOCO., rebuilt	£750
3ft. gauge, 5in cylr. LOCO., thoroughly overhauled	£500
Two Four-coupled 0-4-2 type Kerr-Stuart ENGINES, 8in. cylinders. Overhauled. 150 lb. w.p. for 2ft. 6in. or 2ft. 9in. gauge each	£650

JOHN FREDERICK WAKE, DARLINGTON. 714 G

Tank and Railway Wagons:

40 large 12-Ton HOPPERED WAGONS, bottom doors each	£75
80 very good 12-Ton main Line COAL WAGONS, five doors each	£125
100 10-TONNERS, sides falling full length, rebuilt each	£75
100 10-Ton GOODS WAGONS, side doors each	£75
10 12-Ton DOUBLE BOLSTER WAGONS each	£75
15 10-Ton SINGLE BOLSTER WAGONS each	£55

The above wagons have laminated Spring Buffers, are thoroughly overhauled for works purposes; also a Number of 10 and 12-Ton MAIN LINE WAGONS for Coals, Goods, &c. Enquiries invited.

25 10-Ton COVERED VANS for Main Lines each	£100
Three 10-Ton Rectangular TAR TANKS for Main Line each	£135
40 3ft. gauge SIDE TIP WAGONS, steel tops, oak underframes each	£25

JOHN FREDERICK WAKE, DARLINGTON. 715 G

Tanks:

One 45ft. × 5ft. 6in. Egg End BOILER TANK	£110
A number of CYLINDRICAL and RECTANGULAR TANKS for liquids and air. Particulars on application.	

Hydraulic Machinery:

800 H.P. PUMPING ENGINE, by Hick-Hargreaves, Corliss valves, pumps for 2½ tons pressure per square inch.	
Worthington COMPOUND PUMP, cylinders 12in. and 20in. × 15in. stroke, 160 lb. steam pressure, rams 4¼in. diameter, 1500 lb. w.p.	£250
Fielding and Platt HYDRAULIC PUMP, steam cylinders 10in. × 15in. rams 1¾in., for 1500 lb. w.p.	£110
Belt-driven three-throw HYDRAULIC PUMP, 2¾in. plungers	£65
HYDRAULIC ACCUMULATOR, 5in. ram, 10ft. stroke, steel casing	£115
Three Hydraulic Single-ended PUNCHING and SHEARING MACHINES, by Fielding and Platt.	

Steam Pumps:

Special 300ft. series TANGYE PUMP, cylinder 14in., pump 10in., stroke 24in., suction 10in.	£80
Evans SINKING PUMP, cylinder 12in., pump 7in., stroke 12in., suction 5in.	£80
Four PULSOMETER PUMPS, low prices.	
Six CENTRIFUGAL PUMPS, 4in. to 8in. outlets, belt and engine driven.	716 G

JOHN FREDERICK WAKE, DARLINGTON.

For Sale.—32-Ton Hand Travel- LING CRANE, 42ft. span, girder type, double chain. 35 H.P. Type "F" CROSSLEY GAS ENGINE. Apply, DAVIES and METCALFE, Ltd., Romiley. 10 G

For Sale, 500-K.W. Exhaust STEAM TURBO ALTERNATOR, 1500 r.p.m., 2200 volt, 3-phase, 25-cycle, complete with Condenser. Can be seen on load by appointment.—For further particulars address, 648, The Engineer" Office. 648 G

PLAYER'S POWER HAMMERS.

Z75

W. & J. PLAYER, BIRMINGHAM.

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. VI.*

IN the year 1908 Messrs. Hornsby, wishing to demonstrate the advantages of the chain-track system for travelling at high speed over sand, purchased a 75 horse-power Mercédès motor car, and fitted to it a special form of chain track. The converted machine is shown in Fig. 60. We understand that it was run daily on the dry, loose sand on Skegness Beach for about five months, and that the speed attained was upwards of 20 miles an hour. It will be observed that the construction differs to a considerable extent from that of any of the cars hitherto alluded to, one of the principal differences being the pair of large wheels in the centre, which bear on the track at the bottom, and take the weight of the track at the top. As can be imagined, the machine attracted a good deal of attention, and it was inspected on several occasions by members of the Mechanical Transport Committee of the War-office.

In 1908, too, Messrs. Roberts and James took out two further patents, both of which were concerned with improvements in endless tracks. In the first patent, No. 4862 of 1908, three alternative methods of forming the tracks were described. As all three were very similar, a description of one will suffice to show the trend of the invention, and for this purpose we have chosen the first. It is illustrated in the drawings in Fig. 61. As in former patents, the track is made up of inside and outside links, but their form and method of jointing are different from those previously described. In the drawing A A are the inside, and B B the outside links. Both are U-shaped in cross section. The former are in one piece, while the latter are divided longitudinally into two parts. Each of the inside links has formed on it at the upper part of each side and at each end a boss C, which may be square, hexagonal, or any other convenient shape in cross section, and has fitted upon it a sleeve D, the outer surface of which is cylindrical. Each of the outside links is also furnished at each end and at each side with a boss E, which has an hexagonal, square, or other polygonal hole in it, into which fits a bush F. This boss may either have a cylindrical body and polygonal flanges, as shown in the drawing, or it may be of polygonal shape throughout. To hinge the inside and outside links together, the sleeves D are passed into the bushes F, and are locked together by means of the bolts G. Each of the inside links is formed at its lower part with a pair of lugs H H at each end. These lugs are adapted to pass into and bear against pockets I I, formed at the lower part of each end of the outside links. The bottoms of the adjacent U-shaped links also bear against one another so as to form an unbroken track for supporting the wheels, and in order to obtain a smooth rolling surface, the adjacent ends of the links are made with diagonal surfaces J J, as may be seen in the plan view. For use with specially heavy vehicles the inventors proposed to let into the bottoms of the links renewable strips K. The inside links were, as in the former patents, fitted with blocks of wood, or other material, to act as treads. A diagram of a complete track made in accordance with this invention is given at the right-hand bottom corner of the engraving. In this M M are the sprocket wheels which engage with the bosses E on the outside links B ; N N are the wheels or rollers which support the vehicle and roll on the bottoms of the links A and B ; O is the adjustable jockey pulley supporting the upper part of the track ; and P P are shields which are supported from the frame by supports Q—see the drawing in the right top corner of the engraving. These shields are to prevent dirt from dropping from the top part of the track into the U-shaped channel formed by the lower part.

In the second patent—No. 16,117 of 1908—no less than five new and different methods of forming the track are claimed. We illustrate the first and the last two in Figs. 62 and 63 respectively, but shall not refer to them in great detail, as our readers will have no difficulty in understanding them for themselves in the light of what has been said in the foregoing. It may be said, however, that under this patent the inside links are made in five pieces, and the outside links in three pieces. These inside links comprise two inner plates or side pieces, a distance piece secured between these side pieces and forming a portion of the roller path on which the track wheels run, and two loose pieces or outer bars provided with distance pieces, by means of which, when they are attached to the side pieces of the link, spaces are left to form jaws for the

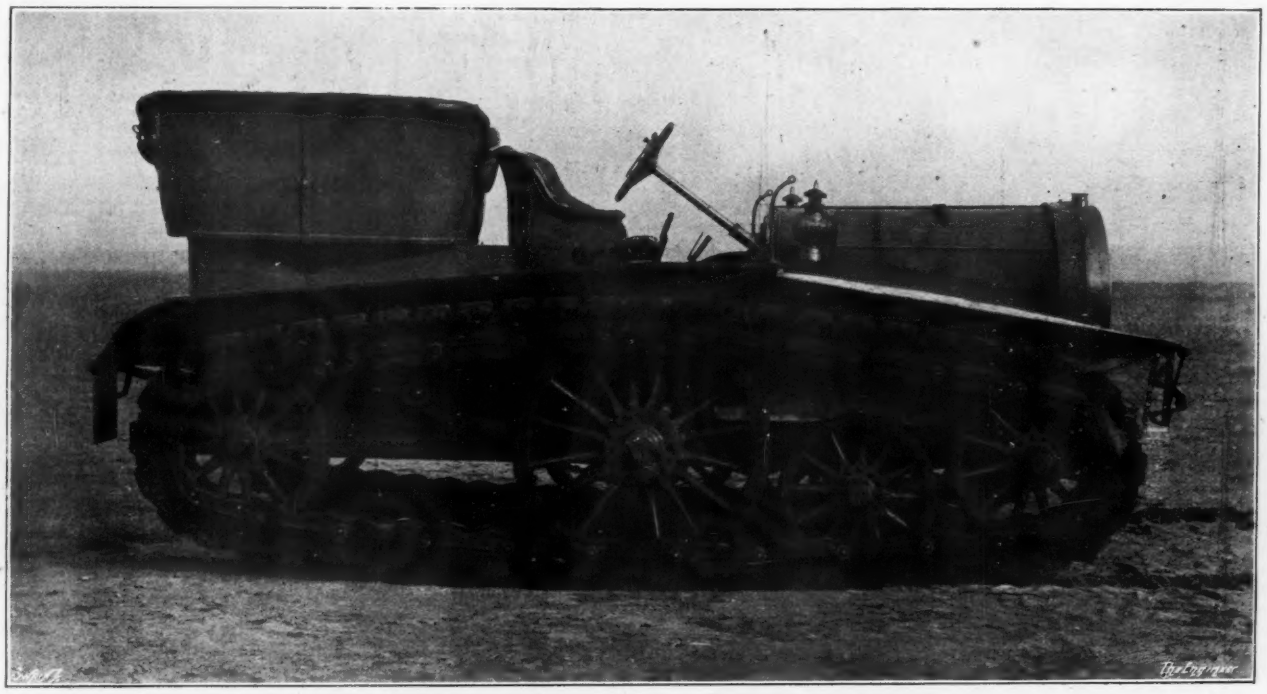


Fig. 60—MERCEDES CAR FITTED WITH CHAIN-TRACK BY HORNSBY'S, 1908

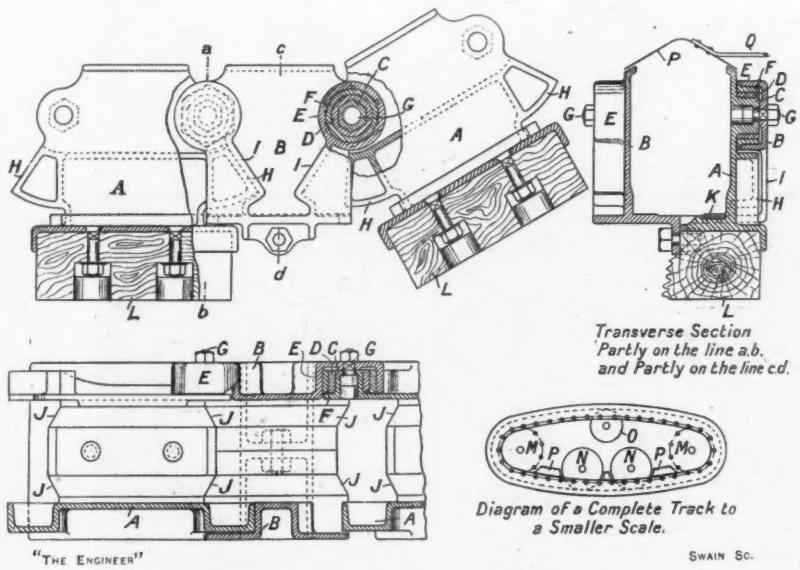

Transverse Section
Partly on the line a.b.
and Partly on the line c.d.
Diagram of a Complete Track to a Smaller Scale.
"THE ENGINEER"
SWAIN SC.

Fig. 61—ROBERTS AND JAMES CHAIN-TRACK, 1908

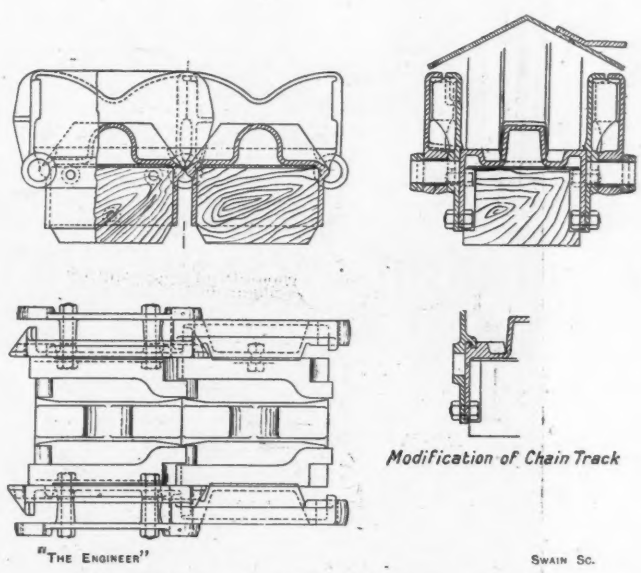


Fig. 62—ROBERTS AND JAMES CHAIN-TRACK, 1908

* No. V. appeared September 7th.

on the truck and the groove on the wheels, a rib on the wheels may enter a groove on the track.

In the modification shown in Fig. 63 the distance pieces forming the roller path may be made of a resilient material, such as india-rubber, woodite, vulcanised fibre, &c., in which case the bolts holding the plates A, B, and the bars C, are carried right through the link. The lower member of the girder is formed of hinge pins, as in previously described cases, but the upper or tension member is formed by carrying up the plates A and B, and forming at their apex pins D, to which bands E of leather, or similar material, are attached. In the modification shown in the topmost engraving, a tension rod F is pin-connected at G on each link, the other ends of the rods passing through holes in pins H on the next adjacent link, these pins being capable of revolving on their axes.

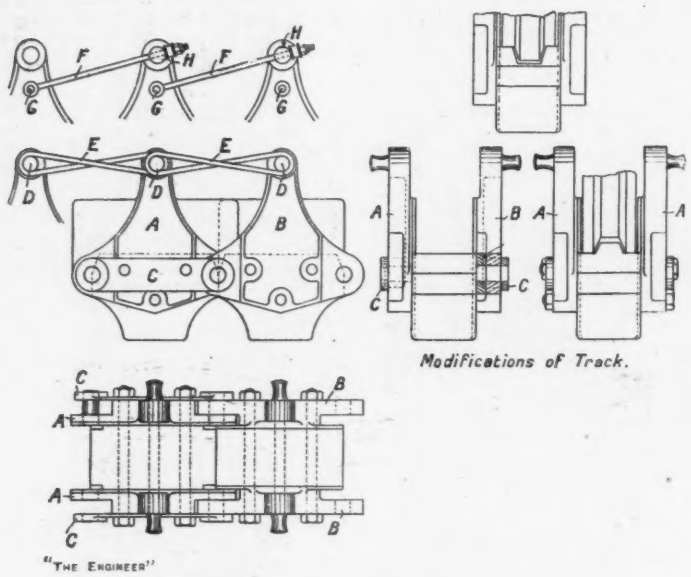


Fig. 63—ROBERTS AND JAMES CHAIN-TRACK, 1908

In July, 1909, Messrs. Roberts and James took out their final patent dealing with this subject. It was numbered 16,436, and was for an improved construction of the driving axles of chain-track tractors, so that the locomotive might be under better control, when running on bad ground or in difficult places, than had up to then been the case. This was brought about by arranging (*a*) that the full power of the engine might be transmitted either to the right or left-hand chain track as required, the other track being free, or even braked so as to make turning still more speedy; and (*b*) that both side tracks might be driven at the same speed for travelling in a straight line. The arrangement is clearly shown in the drawing, Fig. 64. In this A is the main driving axle and B the centre gear wheel of the compensating gear which carries the main driving wheel C, which is driven by the engine. D D are pins attached to the compensating gear wheel B, and E E are bevel pinions mounted loosely on them. F is the left-hand bevel wheel which is keyed to the driving axle A, and G the right-hand bevel wheel which is mounted on it. These two wheels F and G gear, of course, with the pinions E E. H is a claw clutch formed on the inner face of the bevel wheel G, and I is a claw clutch which slides on keys J formed on the shaft A, and engages with the clutch H to lock the compensating gear, K and L being collars by means of which this clutch is moved axially. O is the winding drum, and P a claw clutch formed on its outer face. Q is a claw clutch with two faces R and S, and T is the collar by which this clutch is caused to slide axially either to the right or left on keys U formed on the axle A. V is the left-hand sprocket wheel which is loosely mounted on the axle A, and W is a claw clutch formed on the inner face of its boss, X being the steering brake drum which is also attached to it. Y is the left-hand chain track which is propelled by the sprocket wheel V. Z is the right-hand axle bearing in which revolves the sleeve A^1, to which sleeve is attached the right-hand sprocket wheel B^1 which carries the right-hand steering brake drum C^1. D^1 is the right-hand chain track which is propelled by the sprocket wheel B^1, and E^1 is a claw clutch which is formed on the outer face of the boss of the right-hand bevel wheel G, and which can be brought into engagement with the claw clutch F^1, which slides on keys formed on the sleeve G^1. H^1 is a collar by which the clutch F^1 is actuated, and J^1 J^1 are collars holding all the wheels in position on the axle.

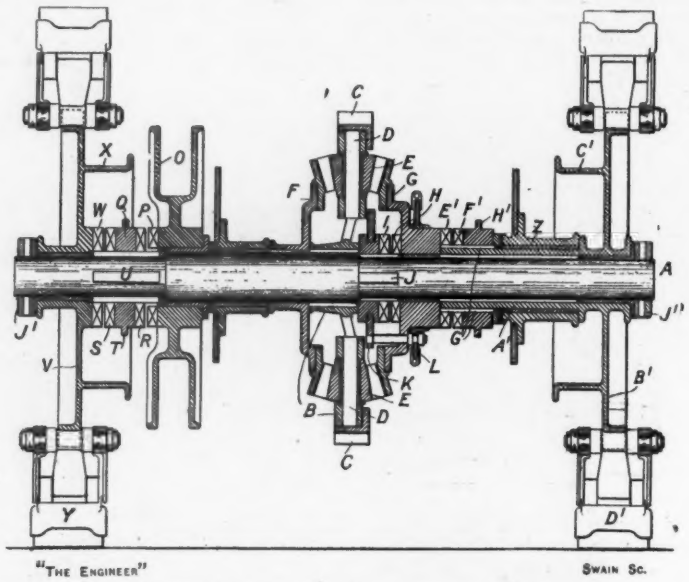


Fig. 64—ROBERTS AND JAMES TRACK DRIVING MECHANISM, 1909

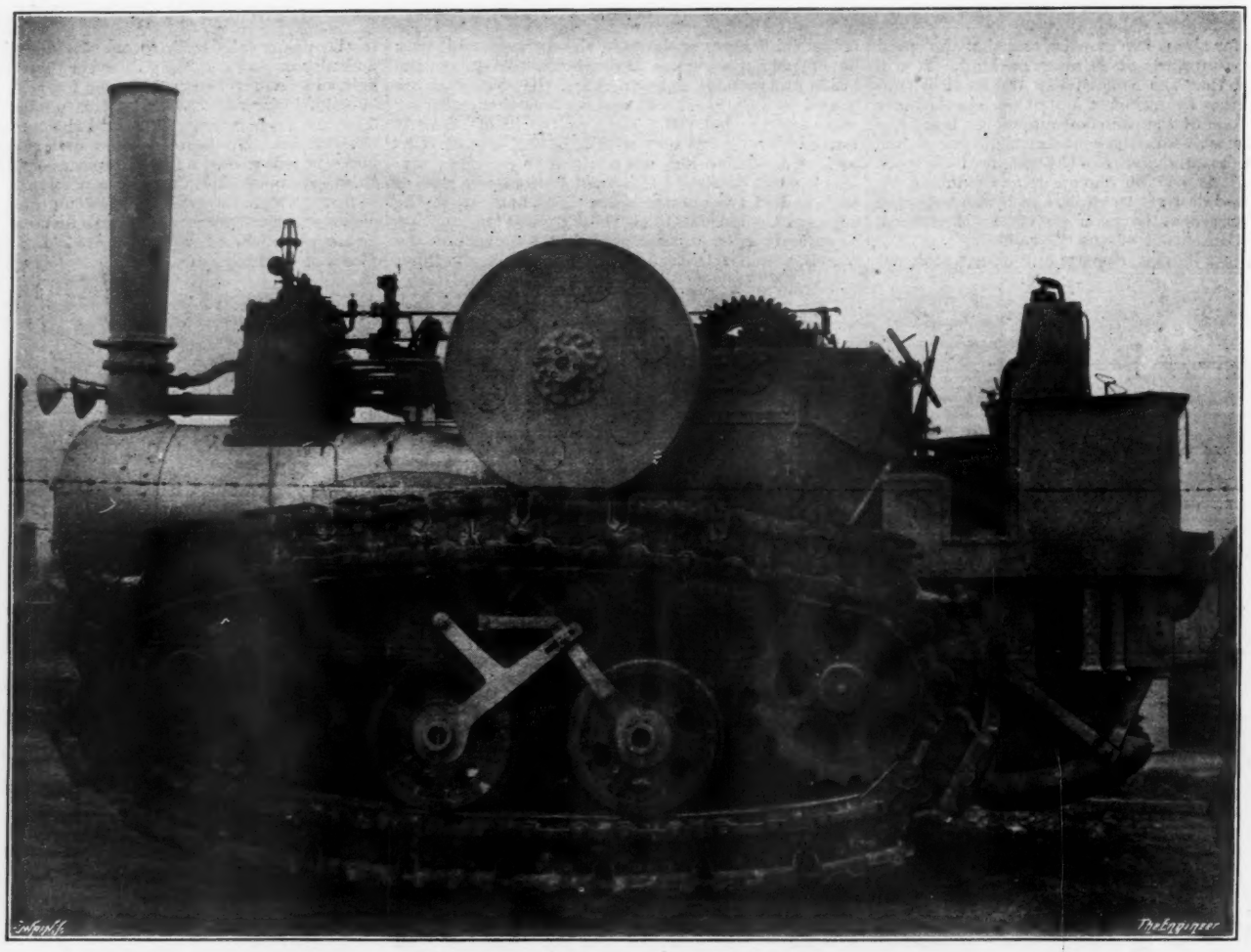


Fig. 65—THE HORNSBY CHAIN-TRACK TRACTOR OF 1909

As shown in the engraving, all the clutches are out of gear. Suppose that it be desired to propel and steer the vehicle in the ordinary way. To do this the clutch Q is slid axially to the left, so that its face S interlocks with the face W, formed on the sprocket wheel V; and the clutch F^1 is moved to the left, so that it interlocks with the clutch E^1 on the bevel wheel G of the compensating gear. The drive will then be transmitted to both chain tracks equally, and the machine will travel in a straight line. Steering is effected by applying brakes either to the drum X or to the drum C^1 as may be required.

When it is desired to apply the full power of the engine to the left-hand chain track, so that the vehicle may be turned to the right, the claw clutch F^1 is disengaged from the clutch E^1, and the compensating gear is locked by the clutches I and H, the claw clutch Q being slid axially to the left to engage with the claw clutch W. The brake is also applied to the brake wheel C^1. Similarly, to apply the full driving power to the right-hand chain track, the claw clutch Q is slid out of gear with the clutch W and into its central position, and the clutch F^1 is put into gear with the clutch E^1 on the bevel wheel G of the compensating gear so as to lock the latter through the sleeve A^1 to the sprocket wheel B^1. The brake is also applied to the left-hand brake wheel X.

In order to complete the account of Messrs. Hornsby's connection with the development of the caterpillar tractor, we may say that in the latter part of 1909 they built the steam chain-track tractor, which is shown in Fig. 65. This machine will be observed to differ but little, so far as its tracks are concerned, from previous machines. Its boiler and steam engine were, it is to be noted, made by Wm. Foster and Co., Limited, of Lincoln, and Mr.—now Sir, William—Tritton was present at and assisted during the trials of the machine, which were held near Grantham in March, 1910.

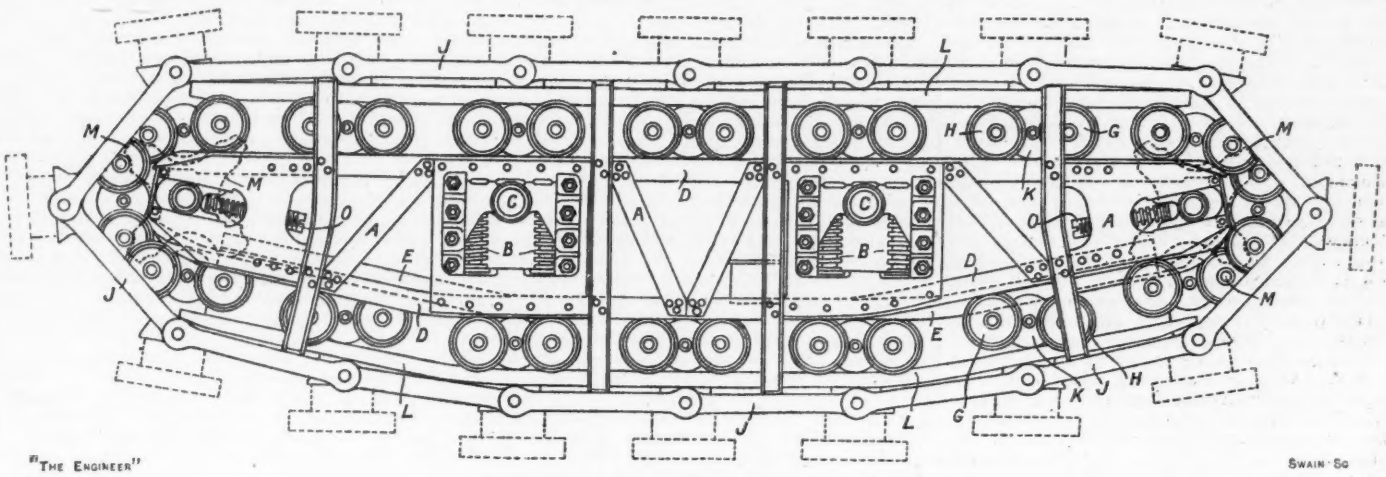


Fig. 66—THE DIPLOCK ORIGINAL CHAIN TRACK, 1910

There can be no doubt, from what has been said in the foregoing, that Mr. Roberts and his colleagues at Messrs. Hornsby's works had a considerable share in the evolution of the chain-track system, and the evidence appears to be very strongly in support of the claim, that they were the first to make a tractor of this type which would successfully haul heavy loads over boggy land, loose sand, up soft steep gradients, or up an incline of 1 in 2 on slippery clay; and we believe that they were the first successfully to take a vehicle over trenches. The first time this was done publicly was, we understand, at Aldershot in 1908, when the machine went over a trench some 4ft. wide and 5ft. deep.

Having developed the system up to the pitch to which we have referred, Messrs. Hornsby found, however, that the Mechanical Transport Committee of the War-office was not in possession of a grant sufficient to proceed further, and they, therefore, decided to abandon development of their chain-track or caterpillar tractor, as it had by then come to be called almost universally. In November, 1912, they sold most of their foreign patents to the Holt Manufacturing Company, of Stockton, California, and the Holt Caterpillar Company, of New York.

The first chain-track of Mr. B. J. Diplock was patented in 1910, and was numbered 3107. Its general design is shown in Fig. 66, while certain parts of it are illustrated in Fig. 67. The invention is applicable to both self-propelled and other vehicles,

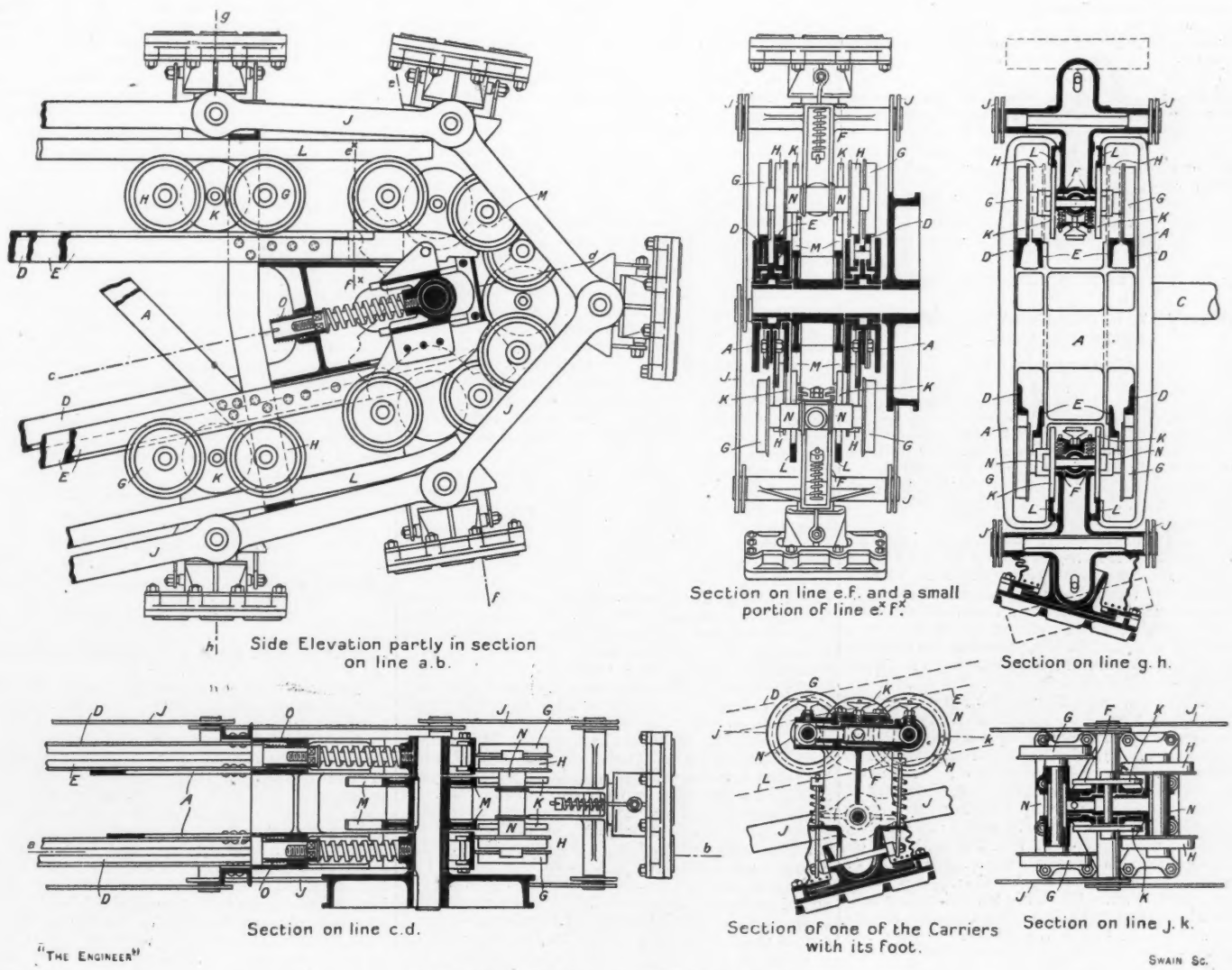

Side Elevation partly in section on line a.b.
Section on line e.f. and a small portion of line $e^x f^x$.
Section on line g. h.
Section on line c.d.
Section of one of the Carriers with its foot.
Section on line j. k.
"THE ENGINEER"
SWAIN Sc.

Fig. 67—DETAILS OF THE DIPLOCK CHAIN TRACK, 1910

and its working will be readily understood by the aid of the drawings. According to it the feet carriers are guided in a vertical plane in such a manner that they move parallel to themselves at the times when the feet they are nearing the ground line, and preferably also when they are rising from it. It may be described as a development of the Pedrail, since Pedrail-like feet are linked together to make up the endless chains. In the drawings A is the frame and B B are springs supporting axles C. In Fig. 66 two axles C are shown, but it is explained that there need only be one. Attached to the frame A are two sets of rails, D and E. The feet carriers F are each provided with two pairs of wheels, G and H, which run respectively on the rails D and E. At the points corresponding to the places where the feet are just above the ground, the rails D and E are arranged at different levels, as may be seen in Fig. 66 and in the drawing at the right top corner of Fig. 67, this being done in order that the carriers may be kept horizontal as they approach and leave the ground. The carriers F are connected together by links J so as to form endless chains. On each carrier there is a third pair of wheels K, the axle of which runs in bearings which are free to move in guides in the frame of the carrier, and is acted on by springs in such a manner that the wheels K are pressed against the rails L, and the carrier is thus kept steady during its movement.

A sprocket wheel M is arranged at each end of the frame A, and the teeth of these pass between adjacent carriers F and engage with the tubes N, which form the bearings for the axles of the wheels G and H. The bearings, in which run the axles of these sprocket wheels, are free to move in guides in the frame A, and are acted upon by screws O, so that any wear in the chains of links can be taken up. The rails D and E are made telescopic to allow of this movement, as is shown in the top left-hand drawing in Fig. 66.

The feet, though not exactly like those of the original Pedrail, bear, as will be seen, a distinct family likeness to them. It will be observed that they consist of a sole plate, having a circular flange projecting from its upper surface, while on its under side is fixed a cellular grating which is designed to contain blocks of india-rubber, wood, or other suitable material. A plate is fixed to the flange on the top of this plate, and it forms a guide for the flange of a cup, which works on a bulb fixed to the frame of the carrier F. A very small longitudinal, but a considerable transverse play is allowed to the flange of the cup by means of a pivot pin which works in slots in the bulb, and the movement of the ends of which are controlled by springs. A loose bag of leather or other flexible impervious material encloses the working parts so as to keep out the dust. Several modifications in design are shown and described in the specification, but into the details of these we need not enter. Only one vehicle was made to this pattern, and it was not a tractor. It was built in the year 1911, and will be illustrated in a later article.

LOCOMOTIVE PERFORMANCE ON THE NORTH-EASTERN RAILWAY.

(By a Correspondent.)

No. II.*

NORTH of Newcastle the grades are mostly against down trains for the first 9 miles, and include 2½ miles at 1 in 200, and 1½ mile at 1 in 224; the next 3 miles are mostly falling, the steepest being 1 in 217 for 1½ mile, succeeded by 1¾ mile at 1 in 261, followed by 2 miles falling, but here the Morpeth Station and curve intervene, necessitating a reduction of speed to 10 miles an hour; however, the fall continues for 5 miles more, and then there is an easy rise for 2 miles, after which the line undulates for 11½ miles to Alnmouth, though tending downwards on the whole. Then comes the Longhoughton bank, 3½ miles at 1 in 170, and after 2 miles of undulation there is a descent of 2½ miles at 1 in 150, known as the Christon bank. The next 16 miles which are practically level, are follrwed by the Scremerston bank, 3½ miles, mostly rising at 1 in 190, succeeded by 2 miles fall at 1 in 245 and 490, and then a rise of one mile at 1 in 203. Here we reach Berwick—with a speed restriction of 5 miles an hour—and are on North British metals thence to Edinburgh. The first 5 miles of "foreign" territory rise mostly at 1 in 190, but finish with 1 in 400. They are followed by 3½ miles level and slight fall, after which is a 9 miles rise, generally at 1 in 200, but finishing with grades of 1 in 300 and 500 on either side of Grant's House Station. After ½ mile of easy grading comes the steep Cockburnspath bank, beginning with 4½ miles fall at 1 in 96, and ending with 1¾ mile at 1 in 210. This is a serious obstacle for up-trains, while down-trains are unable to take full advantage of the fall owing to curves necessitating cautious running. Then come 3 miles nearly level, and a like distance at 1 in 200, and 300 falling, while the next 5 miles are rising, at easy grades, however. The next 20 miles are undulatory, the ruling grade being 1 in 300; while the final 2 miles are rising, first at 1 in 300, but steepening on the last mile to 1 in 78.

Turning now to performance on this section, one of Mr. Worsdell's "Atlantics" took 350 tons from Newcastle, to passing Morpeth, in 22 min. 54 sec. for the 16 miles; recovering from the slack, the next 18½ miles of fluctuating grades to Alnmouth occupied 18 min. 59 sec. On the rise of 1 in 170 to Longhoughton, no lower speed than 40 miles an hour was recorded, and a distance of 51½ miles was traversed in the even hour, despite the Morpeth slack and a slight reduction of speed over the water-troughs at Lucker. The remaining 15½ miles to the stop at Berwick were covered in 16¾ minutes, so that the total time from Newcastle was 76 min. 35 sec. for the 66¾ miles.

Restarting, a rate of 40.2 miles an hour was attained on the rise of 1 in 190 to Burnmouth, while on the rise of 1 in 200 to Grant's House, the minimum was 40.5 miles an hour, and the initial and hard 16½ miles to the summit were covered in 26¼ minutes. No higher speed than 65.2 miles an hour was recorded on the descent of 1 in 96, the brakes being several times applied; but on the falling grade of 1 in 210 which follows a maximum of 72.5 miles an hour was noted, and Dunbar, 28¼ miles, was passed at 69.2 miles an hour in 38 min. 23 sec. As the booked allowance from Berwick to Edinburgh was 79 minutes, this left 40¾ minutes for the remaining 29¼ miles; the actual time occupied was 39 min. 12 sec., but this included four bad signal delays, so that the net time for the 57½ miles would be about 70 minutes.

On the up journey a similar engine hauled a train weighing 380 tons, with which Longniddry, 13¼ miles from Edinburgh, was passed in 17¼ minutes, and Dunbar, 29¼ miles, at the mile-a-minute pace, in 33 min. 50 sec. The minimum on the Cockburnspath bank of 1 in 96 was 24.4 miles an hour, the 6 miles of rising grade from Innerwick to the summit having occupied 9 mnn. 24 sec. This 40 miles from Edinburgh had thus consumed 52¼ minutes, and the remaining 17½ miles to Berwick were easily covered in 17 min. 47 sec., making a total of 70 min. 2 sec.

Restarting, Belford, 15¼ miles, was cleared in 19 min. 25 sec., and Chathill, 21 miles, in 25 min. 54 sec. On the 2½ miles rise at 1 in 150 beyond Christon Bank Station, the speed did not fall below 50 miles an hour—excellent work this; while on the descent of the Longhoughton bank the maximum was 69.2 miles an hour, Alnmouth being passed in 37 min. 58 sec., distance 32 miles. The next 18¼ miles to Morpeth were covered in 17 min. 32 sec., again excellent work with such a load, as this length includes 9 miles of rising grades, even although there is nothing steeper than 1 in 203, and 53 miles were traversed in the even hour from the Berwick start, including the Morpeth slow; this good running resulted in Newcastle being reached in 76 min. 3 sec., the gain on schedule time from Edinburgh being 4 minutes.

No. 728, a three-cylinder "Atlantic," starting from Newcastle with a load of 360 tons, and severely hampered by a north-westerly gale, managed to pass Morpeth, with the usual careful reduction of speed, in 24 min. 33 sec., and Alnmouth, 34¾ miles, in 43 min. 48 sec., this included a slight check; nevertheless, the minimum at the summit of the Longhoughton bank, which follows, was 39.1 miles an hour, and a maximum of 70.3 miles an hour was noted on the descent, while the 27¼ miles from the summit to passing Berwick at 5 miles an hour, and including a slack through Tweedmouth, were covered in 28 min. 13 sec., so that the total time to Berwick was 77 min. 32 sec., by no means bad work with four delays and a rough side wind. On the 5 miles rise to Burnmouth, a rate of 40.9 miles an hour was attained, and the final ascent to Grant's House was commenced at 60 miles an hour, falling to 45 miles an hour at the summit. Within two miles on the descent, the speed rose to 62.5 miles an hour, but the brakes were then applied, so that this proved to be the maximum on the fall of 1 in 96, and we did not reach this rate again until approaching Dunbar, passed in 113 min. 36 sec. and 36 min. 4 sec. from Newcastle and Berwick, distances 95 and 28¼ miles respectively. The stop was made at Edinburgh in 69 min. 2 sec. from Berwick, the throughout time being 146 min. 34 sec. for the 124¼ miles; but it was evident that, despite the unfavourable weather conditions, faster running could have been achieved had it been necessary.

No. 737, with 265 tons from Newcastle, encountered a bad check at Annitsford, but passed Morpeth in 23 min. 49 sec. The 18¼ miles thence to Alnmouth were covered in 17 min. 58 sec., with a maximum of 66.2 miles an hour. The minimum on the Longhoughton rise was 42.8 miles an hour, and 70.3 miles an hour was recorded on the subsequent descent. A slight reduction of speed was made over the water-troughs at Lucker, after which on an almost level track the rate increased to 68.2 miles an hour. The pace did not fall below 45 miles an hour on the 1 in 190 rise to Scremerston, but then came signal delays, and after passing Berwick in 74 min. 41 sec.—50 min. 52 sec. for the 50¼ miles from Morpeth—we came to a dead stand for signal, so that we had to restart on a grade of 1 in 190. However, we ascended the Grant's House bank at a minimum speed of 43.3 miles an hour, and descended in the usual cautious manner; but on the easier grades which follow, a maximum of 72.5 miles an hour was noted, and Dunbar was cleared in 112 min. 8 sec., travelling time. After this the engine was worked easily, and after two further signal delays we stopped at the magnificent Waverley station in 146¼ minutes, 139½ minutes net time.

With 310 tons, No. 714 had no sooner started from Edinburgh than adverse signals were encountered, but after Portobello no further delays were experienced, Longniddry being passed in 18 min. 46 sec., and Dunbar in 34 min. 8 sec. The speed at the latter station was 65.2 miles an hour, and at Innerwick it was 60 miles an hour. Ascending the 1 in 210, the rate fell to 56.2 miles an hour, and to 28.4 miles an hour on the 4 miles of 1 in 96, the time for the Cockburnspath bank being 6 min. 3 sec., and the summit was reached in 48 min. 40 sec. from the start. The following 8½ miles of falling grade, mostly at 1 in 200, were run "easily," no higher speed than 66.2 miles an hour being recorded, while on the descent of 1 in 190 from Burnmouth, the rate was not allowed to exceed 61.6 miles an hour; nevertheless, we arrived at Berwick in 68 min. 36 sec., 67 minutes net, representing an economy of 4 minutes on the booked allowance.

Thence, with the same load, a maximum of 67.2 miles an hour was reached on the fall of 1 in 190 beyond Scremerston, and Belford was cleared in 17 min. 46 sec. Speed was reduced when passing over the Lucker water-troughs and Christon Bank station, 24 miles, was passed in 27 minutes, the rise at 1 in 150 being ascended at a minimum of 45 miles an hour, while descending the Longhoughton bank the maximum was again 67.2 miles an hour. Alnmouth was threaded at reduced speed in 35 min. 46 sec., and Morpeth, 50¼ miles, in 55 min. 11 sec. Recovering from the slack at the latter station, 49.5 miles an hour was attained on the rise of 1 in 286, and on the rise of 1 in 217 to Plessey the rate did not fall below 50.5 miles an hour, while on the final 11 miles of easy grades, although mostly downhill, the rate never exceeded the mile-a-minute pace; the stop at Newcastle being made in 76 min. 8 sec., a gain on schedule time of nearly 2 minutes.

The above three performances are typical of the work of Sir Vincent Raven's three-cylinder "Atlantics" with the Scotch expresses between Newcastle and Edinburgh.

IN conclusion, it will be remembered that Mr. Worsdell was the first locomotive superintendent to introduce six-coupled express engines on an English railway, and although now generally relegated to fast goods train duties, they are useful for express work when required, as the following will show. With a load of about 290 tons the six-coupled engine covered the first 5 miles from Newcastle, almost all uphill, and including 2 miles at 1 in 200, in 9 min. 7 sec., while on the 1½ mile rise to Cramlington the speed did not go below 48.4 miles an hour, after which we were badly delayed; but Morpeth was passed in 23 min. 34 sec. and Alnmouth in 42 min. 26 sec. The minimum on the Longhoughton bank was 39.1 miles an hour, and on the following descent a maximum of 69.2 miles an hour was attained. At Newham a bad check was experienced, reducing the speed to about 15 miles an hour; but so smartly did the engine recover that within five miles of the delay the speed had increased to 65.2 miles an hour. Owing to further delays the last three miles to Berwick required nearly 8 minutes, the total time to that station being exactly 80 minutes; but of this fully 5½ minutes must be deducted for delays. Burnmouth was passed at 40.9 miles an hour, and the minimum at Grant's House was 42.8 miles an hour. Down the Cockburnspath bank a maximum of 67.2 miles an hour was recorded before the brakes were applied, and on the fall at 1 in 210 approaching Innerwick, a like speed was noted; but then the engine was "eased," and Dunbar was cleared in 116 minutes, 4 minutes ahead of time. Approaching Portobello we were badly checked, and later almost stopped by signal; nevertheless, we stopped in the Waverley station in exactly 153 minutes, the train having arrived 7 minutes in advance of the advertised time, while, if the signal delays be allowed, the net time would be about 2 hours and 25 minutes.

* No. I. appeared September 7th.

PLYMOUTH AS A COMMERCIAL PORT.

THE incident of a ship carrying a food cargo calling at Plymouth to land passengers and mails, proceeding elsewhere to discharge, and being torpedoed has drawn fresh attention to the need for an extension of the commercial dock facilities of this great western port. Plymouth is not at the present time destitute of commercial unloading facilities, which might have been utilised to prevent the loss of food supplies, and if these are still on a somewhat modest scale, it is because the Admiralty has until now viewed the commercial development of Plymouth with disfavour. An intimation which has been recently received, that this attitude is no longer maintained, and that any scheme of commercial development which appears to be in the general national interest will not be vetoed by the Government has changed the situation, and development of the port may now be anticipated; but before giving an account of the plans for extending the commercial dock facilities which, in consequence of this relaxation of Admiralty restrictions, are receiving consideration, it will be of interest to review briefly what has been already done to meet the requirements of commercial shipping.

The Millbay Docks of the Great Western Railway include a floating basin with a total area of 13 acres and a depth of 22ft. at spring tides, a wharf on the

western side of the outer harbour 800ft. long, with a depth alongside of 24ft. at low water springs, as well as three stone piers and a floating pontoon with depths of water ranging from 14ft. to 20ft. The whole accommodation gives a total length of piers and quays of 1½ miles. The docks are well equipped with handling appliances, including a 25-ton hydraulic crane, and capacious sheds and warehouses have been provided. There is also a dry dock with an extreme length of 454ft. and a width of 90ft. with 22ft. of water over the blocks. Other facilities have been provided at Stonehouse Pool, where the London and South-Western Railway has interests at Richmond Walk and elsewhere, of which full advantage has not been always taken. The Corporation, thwarted in the proposal to carry out a more ambitious scheme, constructed a small wharf in the upper part of the Cattewater, the eastern arm of the harbour, which with certain auxiliary works was completed to the designs of Sir John Wolfe Barry and Partners, shortly before the outbreak of war. Other facilities have been provided in the Cattewater at the Victoria Wharves and elsewhere, and this part of the harbour has been dredged. In a memorandum communicated to the Minister of Shipping the Corporation point out that there is a large area of vacant land adjoining the Cattewater, both in its upper and lower reaches, admirably adapted for the provision of cold storage accommodation and for the erection of warehouses and handling plant. Thirty acres of such lands, which are owned by the Corporation, have been placed at the free disposal of the Government for the period of the war, and if desired, for five years after its termination. This offer has, up to the present time, brought no satisfactory response from the Government; but private interests, in view of the declared desire of the Admiralty not to stand in the path of legitimate expansion, have put forward a somewhat important scheme for developments in the Cattewater.

It is in this section of the harbour that commercial activities have always centred. It was in the Cattewater that a national navy was assembled, for the first time, in the reign of Edward I., while in subsequent years, during the French wars, the enemy more than once anchored his ships in the Cattewater and despoiled the town and shipping. From hee, too, Drake, Frobisher and Hawkins set sail to engage the Armada, and as a memorial stone set up at the entrance to Sutton Harbour reminds us, it was from the Cattewater the Pilgrim Fathers embarked for New England. It was not until the construction of Plymouth Breakwater, two centuries later, rendered the Sound a safe anchorage that the Cattewater ceased to be the only refuge for shipping; but the building of the Mount Batten breakwater at the entrance to the eastern harbour has rendered the Cattewater a safer and more sheltered anchorage than ever before, and the years that have since passed have witnessed many efforts to provide improved commercial dock facilities. Until the last quarter of the nineteenth century, a somewhat important shipbuilding industry was in operation here; but this trade is now dead, and, indeed, some of the modern wharves have been constructed on the sites of extinct shipyards.

It is now twenty years since the Corporation made proposals for an important development in the Cattewater, and the plans at that time projected have formed the basis of most of the subsequent schemes. A report, then made on the engineering aspect by Sir John Wolfe Barry and Partners, showed that a considerable expansion of the commercial facilities could be made at a comparatively modest outlay. It was pointed out that limestone hills on either side of the Cattewater dip down suddenly to considerable depths below the bed of the harbour, the overlying material being mainly silt and mud or clay and sand. A small patch of rock is found at one point at a depth of 12ft. below low water of spring tides, but with this exception the bottom appears to be soft along the channel of the Cattewater. A comparison of Admiralty surveys shows that there has been little or no silting up. At the period when the report was made, there was a depth of 16ft. at low spring tides in the lower section of the Cattewater and 5ft. in the upper portion. The fairway from the Eddystone to the entrance to the Cattewater has an ample depth of water, being nowhere less than 30ft. at low water spring tides, and little, if any, dredging would therefore be required in the approach channel. The rise of the tide at Plymouth is 15ft. 6in. at ordinary springs and 12ft. at neaps; extraordinary springs rising and falling about 2ft. 3in. above and below ordinary springs. It may, therefore, be taken that a depth of 30ft. at low water of ordinary spring tides should be provided for the largest vessels at the lower end of the Cattewater, which would give about 20ft. at the lowest equinoctial tides, while a depth of 26ft. at ordinary low water springs would be sufficient for the somewhat smaller ships to be accommodated at the upper portion of the harbour. The carrying out of the dredging to the suggested depths would have been associated with the provision of a range of deep water quays designed to give 2200ft. of wharf accommodation with a depth of 30ft. alongside and 1850ft. with a depth of 26ft. at low water. This would have allowed berthage to be provided in the lower part of the harbour for four ocean-going ships of large tonnage. A graving dock was also included in the scheme. An auxiliary proposal was for an extension of the Mount Batten breakwater to give additional shelter to ships using the harbour. A reclamation of an area of 18 acres behind the wharves would have provided sites for railway station, sidings, sheds, and warehouses. The railway connections included a line along the whole length of the quays joining the Plymouth and Dartmouth line of the London and South-Western Railway. If this scheme, estimated to cost only £484,000, could have been carried out, the commercial development of Plymouth would have been assured, and passengers and mails would have been landed either at the Breakwater extension, or alongside the new wharves, in place of having to land as at present by tender. More recent proposals on similar lines have aimed at making Plymouth a terminal port for ocean traffic, and combining with the Cattewater deep-water wharves, a tidal dock in the upper section of the eastern harbour. The scheme was not absolutely vetoed by the Admiralty, but the conditions imposed included the removal of the Mallard and Winter shoals near the entrance to the Cattewater, which it was estimated would have involved the expenditure of £1,000,000 on unproductive works. This ruled the scheme out on financial grounds. When ten years later somewhat similar plans were put forward in what was known as the Duke scheme, on which £750,000 was to have been expended, Admiralty opposition was again in evidence.

It was probably the fact that no assent on the part of the Admiralty to commercial dock accommodation at Plymouth was likely to be obtained which led to the recent Wembury scheme. Those associated with that project selected Wembury Bay, which lies to the east of the harbour, as the site of a dock. The project, on which a sum of £2,000,000 was to have been expended, would have provided an enclosed water area of 1000 acres, and included a large inner harbour. In all 13,000ft. of breakwater, seven miles of quays, and two graving docks, each over 1000ft. long, were to have been constructed. A railway line, four and a-half miles long, would have been necessary to link the harbour with the Great Western and South-Western systems. The project would certainly have provided Plymouth with magnificent facilities, but was probably financially unsound.

The plans which are now under discussion in Plymouth, and which have received the general approval of the Admiralty, are put forward by the Victoria Wharves, Limited, with which in its reconstructed form important shipping interests controlled by Sir Owen Phillipps are associated. It was Mr. Duke who was responsible for the beginnings of the Victoria Wharves, which, in their existing form, have a water frontage of 1200ft., and adjacent warehouse accommodation extending over 60,000 superficial feet. The wharves are in direct railway communication with both the lines serving Plymouth, and can be approached at any state of the tide, there being a depth alongside ranging up to 28ft. at low water of spring tides. The plans for extension, which have been prepared by Messrs. Prigg and Lindon, include a pier 700ft. in length, and 150ft. wide, and three new wharves, respectively 800ft., 670ft. and 300ft. in length. There would be six berths with depths of 26ft. and 28ft. at low water, and a site for a graving dock 600ft. long, 100ft. wide, and with 28ft. of water over the sill is included. In order to avoid interference with the known currents—at half tide when the current is strongest it is uniform and averages a knot an hour—it is proposed to construct the new works in open ferro-concrete piling, which would allow free circulation for water. The estimated cost is £750,000, but the complete scheme involves the construction of a large grain silo and additional warehouse accommodation.

At the present time the plans are under the consideration of the Cattewater Commissioners, whose approval is necessary, and it is hoped that their assent may not be long withheld. The delay on the part of the Commissioners in reaching a decision has led to proposals from certain quarters that the whole of the separate port authorities of Plymouth should be welded into a single Harbour Trust, with jurisdiction over the entire port area.

OBITUARY.

PERCY WESTMACOTT.

WE regret to have to record the death, on the 10th inst., of Mr. Percy Graham Buchanan Westmacott. Mr. Westmacott died at his home, Rosemount, Ascot, on the eve of his eighty-seventh birthday. He was born at Edinburgh in 1830, and was educated in that city and at Dresden and Chester. After serving in the offices and shops of Messrs. Miller, Ravenhill and Co., marine engineers, and at sea, he entered Messrs. Armstrong, Whitworth's works at Elswick, in 1851, as a draughtsman. In 1853 he was appointed manager to the firm, and in 1863 he was assumed as a partner. When the firm became a limited liability company he became its managing director, and remained a director until 1913, although in 1887, owing to ill-health, he was compelled to cease his active association with engineering work.

Mr. Westmacott was President of the Institution of Mechanical Engineers in 1883 and 1884. He was one of the early workers in the application of hydraulics to the working of cranes, lock-gates, bridges, grain elevators, and so on, and in this connection he was closely associated with the design and construction of the swing-bridge at Newcastle-on-Tyne. In the construction and development of the Armstrong gun he collaborated throughout. He played an active part in the early days of the Volunteer movement, and raised, and for several years commanded, the 1st Newcastle Engineer Volunteers. He was well known and highly esteemed, not only in engineering circles, but in the artistic world. He was a discriminating collector and had many friends among artists, particularly those of the Dutch school. In this connection it is interesting to note that he was numbered among the few remaining friends of Matthew Maris, the last of the Maris brothers, who died in London a few weeks ago.

CAPTAIN HARRY SIMON.

MUCH sorrow is felt for the family and widow of the late Captain Harry Simon, R.F.A., who died on September 8th of wounds received in action. Captain Simon is the third son of the late Henry Simon to lose his life in the war. He served in the Volunteers and Territorials for some years, resigning early in 1914 owing to business calls. He immediately rejoined on the outbreak of war, and saw active service in Egypt and elsewhere. He was educated at Rugby and King's College, Cambridge, and took an Honours degree in the Natural Science Tripos at Cambridge. Before the war he took a very prominent part in the conduct of the business of Henry Simon, Limited, founded by his late father, but was little seen in public. Only a few months ago he was pressed to consent to his release from military to other work of national importance, but preferred to remain with his regiment. He was thirty-six years old, and leaves a widow, three sons and a daughter. His mother, the widow of the late Henry Simon, has done much self-denying work on behalf of the wounded in Manchester, and has converted her home, at Didsbury, into a Red Cross Hospital.

LATIN-AMERICAN ENGINEERING NOTES.

Argentina.

SOME extensive sanitary works are about to be undertaken in connection with the existing sewerage system of Buenos Aires, the estimated costs of which will amount to 3,824,866 pésos—1 péso = 1s. 9d. The Federal Government has approved plans for the construction of docks and the making of other improvements at Puerto de Arroyo Pareja, near the important port of Bahia Blanca, as well as the repairing of the extensive Rosario docks, the cost of the latter being put at 800,000 gold dols. (= £160,000). The newly-opened Portland cement works in the Province of Buenos Aires are now turning out 3000 barrels of high-grade cement daily. The plant employs over 500 men. A new electric lamp factory is also shortly to be erected, calling for the investment of 3,000,000 dols. (£600,000).

El Salvador.

A native engineer has been commissioned by the President of the Republic to make the necessary surveys, plans and estimates for converting the open roadstead of the port of La Libertád into a protected harbour, a work of much importance in the development of the country. All contractors who are interested will shortly be able to obtain full particulars as to the contracts for the dredging of the port, the construction of wharves, piers, warehouses, &c., and for the building of two breakwaters, one of which will be built near the mouth of the Chilama River, and the other at the extremity of the rocks known as Pena Partida.

Chili.

In addition to the work proceeding at the two ports of Valparaiso and Antofagasta, the Chilean Government will shortly send to Congress a project for the construction of complementary port works at San Antonio, to obtain the necessary funds for which sale of land at the port itself is to be effected. Up till the beginning of June, the expenditure upon the Valparaiso port works had amounted to 11,586,427 gold pésos—1 péso = 18d.—so that, in sterling, this may be put at about £868,981. The total expenditure is fully expected to equal the sum originally contracted for, namely, £3,000,000. Tenders are invited by the Minister of Finance for the primary improvement works at the port of Antofagasta, the cost of which must not exceed £1,700,000. The parties offering must present, at the same time, another tender for taking up the loan of £1,700,000, the product of which is to be devoted to the carrying out of the work in question. The bonds of the loan will bear 6 per cent. interest, to be reduced by amortisation at 2 per cent. annually.

A MEETING was recently held at Genoa of representatives of all the shipbuilding yards, aeroplane constructors, engineers, and others interested to discuss means to be taken against submarine attacks, and the reconstruction of the Italian mercantile marine. *L'Economista d'Italia*, for August 23rd, from which these notes are taken, states that various proposals were considered which would tend to make present and future ships unsinkable. It was decided to nominate a special committee of engineers and technical men to standardise the construction of ships now about to be put in hand, and to specify the number of water-tight compartments with a view to securing the flotability of the ship.

COAL GAS FOR MOTOR VEHICLES.

In our issue for the 31st ult., an article was given which dealt with the substitution of coal gas for petrol, and traced the progress made with the newer fuel. Since the publication of this article there has come to hand a most illuminating report, dealing with experiments conducted with coal gas by the Executive Committee of the British Commercial Gas Association. It was known in the early part of the year that this association had interested itself in the matter, and the report is one which has been awaited with considerable interest by all who have been watching this latest development in motor traction. The committee states, that the only substantial difficulty in the way of substituting coal gas for petrol is the bulk of the gas; accordingly, chief attention has been given to various storage systems, and to such important considerations as the effect of compression on the quality of the gas. As regards the more common method of storing the gas under normal pressure in a large flexible container, it is pointed out that the practical disadvantages of this system are the extremely fragile nature of the holder and its bulky dimensions, which seem to unfit it for hard work in towns. Nevertheless, the simplicity and low cost of the system warrant careful consideration of it as a war measure, because, although the volume of gas that can be carried at atmospheric pressure is limited owing to its bulk, this disadvantage is to some extent compensated for by the ease with which the gasholder can be replenished. Indeed, in view of the present difficulty of obtaining pressure receivers, it is hardly possible to use gas in any other way. It is pointed out that owing to the very low pressure—only about two-tenths of an inch water gauge—exerted by the gas contained in a flexible container, a meter delivering into it discharges practically as though it were open to the atmosphere, and, accordingly, races unless some form of throttle is interposed. A short length of small bore piping or a diaphragm with a suitable aperture is recommended so as to retain the pressure drop in the meter within reasonable limits.

Consideration is given to the method of storing the gas under pressure in steel cylinders, and, for practical reasons, a pressure varying from 20 to 25 atmospheres is recommended. It is particularly instructive to note that the effect of compression on the calorific power of coal gas, if the compression is carried to 120 atmospheres, is a reduction amounting to 10 per cent. In experiments made to test this point, a cylinder of gas at a pressure of 120 atmospheres was discharged through a reducing valve into a calorimeter, and frequent observations of the heat developed were made. It was found that the calorific value remained almost constant during the time the gas was discharging and the pressure falling. There was, however, a rise in the number of B.Th.U. developed during the last few minutes, when the pressure was falling from about three atmospheres to atmospheric datum, presumably due to the partial re-evaporation of some of the hydrocarbons which had been precipitated. The main point, however, is that almost the whole gas can be discharged at a practically constant calorific value, and this value is 10 per cent. lower than before compression.

There was no opportunity of determining, under existing conditions, the effect on calorific value resulting from compression to 20 atmospheres; but from observations made some seven years ago, it was found that the deterioration due to compression to 300 lb. per square inch was from 3 to 4 per cent., so that if due allowance is made for the difference in constitution of the gas at the present day the effect of compression would be almost negligible. Compression, moreover, has its advantages, for up to 20 atmospheres the gas would deposit 95 per cent. of its normal water content, and, as in practice it would have very little opportunity of taking up further moisture on its release from the storage cylinders, it would be employed practically dry. In this way the avoidance of dilution with water vapour would counterbalance the loss of calorific value due to the deposition of hydrocarbons.

HYDROCARBONS PRECIPITATED.

As regards the hydrocarbons thrown down by compression, there is no doubt that naphthalene will be precipitated; but observation shows that there is invariably a sufficiency of liquid constituents to prevent the naphthalene from assuming the solid state. These liquid constituents, however, have a tendency to polymerise; accordingly, it would seem desirable that storage containers should be fitted with drain cocks, while it would be as well if provision were made for the periodical use of a small hand-operated spraying device to facilitate the expulsion of viscid deposits. A further point in favour of moderate compression is the fact that there would certainly be a greater deposit of hydrocarbons at extreme pressures, such as 120 atmospheres, and at the same time there would be greater difficulty in cleaning out the containers. Probably it would be necessary to expel the deposited matter by means of heating, which would entail the dismantling of the vessel—an expensive matter. In time, too, the periodical heating would adversely affect the strength of the cylinders. Another point is that with compression to 120 atmospheres the containers would be smaller while the deposits would be greater than at 25 atmospheres, so that the volumetric capacity of the cylinders would suffer serious diminution unless they were frequently cleaned.

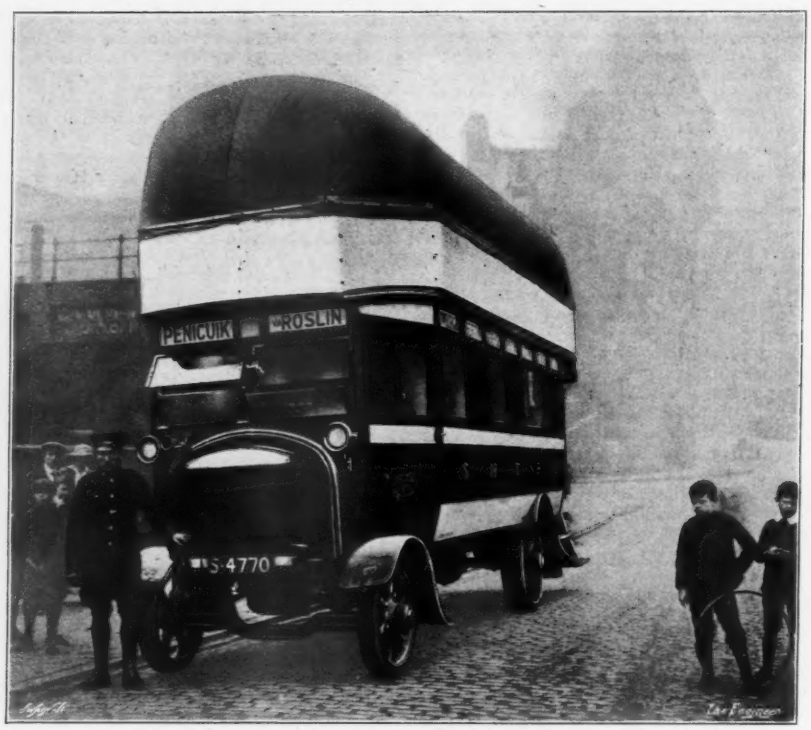
The British Commercial Gas Association equipped a special car for gas-consuming purposes, and carried out experiments in this way. The car was run round a district having about the average kinds of roads and variations of level, and the observations made indicate a radius of action of twenty-five miles per thousand cubic feet of gas. The average speed was nine miles per hour, including the stopping and slowing down, which was several times necessary at crossings, &c., but which is, of course, consistent with everyday conditions. It was not found possible to make comparative brake tests as between gas and petrol; but tests made by Messrs. White and Poppe, of Coventry, show that the brake power developed by a petrol motor when driven by gas is about 85 per cent. of the power developed by petrol, and that this proportion is fairly constant over a wide range of speeds; also for equal brake power on test bench, one gallon of petrol appears to be equivalent to 250 cubic feet of gas. These tests were made with gas compressed to only a few inches; but so far as the data of relative power are concerned, there is no reason for doubting that they apply equally well to gas that has been compressed, making due allowance for loss of calorific value due to compression, which, however—as has already been pointed out—may be regarded as negligible for pressures not exceeding 25 atmospheres. The committee's own observations, derived from general running of a vehicle on petrol and gas, point to a ratio less favourable to gas, namely, that one gallon of petrol is equivalent to 300 cubic feet of gas. Much, however, depends upon the quality of the gas and the kind of petrol used. Several particulars are given with regard to the weight of the cylinders, and it is shown that compression to 120 atmospheres would mean a tangible economy in this direction. There is always the fact, however, that the high-pressure cylinders work at a lower factor of safety, which in turn necessitates a degree of supervision which seems scarcely practicable with reservoirs used for the storage of gas for motor traction. Moreover, the extreme high-pressure cylinders are more expensive per 1000 cubic feet of free gas than are cylinders for the more moderate pressure of 25 atmospheres; but this item, on the other hand, would soon repay its cost by the higher carrying capacity of the vehicle, due to the smaller deadweight.

CHARGING DEPOTS.

So far as the equipment of compressing and storage depôts is concerned, it is recommended that the station units should, for economical as well as mechanical reasons, be of the multiple type rather than in the form of a single reservoir, and should be worked at a pressure rather higher than that required on the car, so as to compensate for the drop of pressure that would take place when the gas was transferred. If when the pressures in the car cylinders and the station storage cylinders had adjusted themselves, this pressure was below the working pressure for the car, direct communication with the compressor would allow of the necessary addition being made. A suitable arrangement of valves would permit of this being quickly done. If the compressor were not supplemented by a certain amount of storage capacity in the form of auxiliary reservoirs, it would have to be of such size as to permit a car to be replenished in, say, five minutes, which would mean a compressor of 12,000 to 18,000 cubic feet per hour capacity, and, unless the demand for gas were high this would add unduly to the standing charges, and, therefore, to the cost of compression.

No trouble has been experienced in the reduction of temperature consequent upon the expansion of the gas after release from the storage cylinder. The gas was observed to chill immediately after release, but nothing else; the conductivity of the metal surroundings being sufficient to make up for the absorption of heat due to the expansion of the gas.

A point in favour of coal gas which must not be overlooked is the extremely clean conditions which prevail with its use. Petrol certainly possesses the immense advantage of containing a large amount of energy in a small space; but coal gas, on the other hand, being for all practical purposes a "perfect gas" and not a vapour, conduces towards clean pistons and cylinders, absence of troubles due to injector stoppage, and the complete elimination of starting difficulties in cold weather. As the gas supplies in different parts of the country are not standardised, either as regards quality or price, the gas obtained in some localities will give a better mileage than that obtained in others; the gas equivalent, however, is unlikely ever to be higher than 300 cubic feet per gallon of petrol, but it may be as low as, or even lower, than 250 cubic feet.



GAS-DRIVEN OMNIBUS FOR EDINBURGH

The Scottish Motor Traction Company, which runs a number of motor omnibuses in Edinburgh and the district, has taken up the use of coal gas, and we understand that the North British Rubber Company, Limited, also of Edinburgh, has supplied them with gasholders. As an example of the form that containers on gas-driven vehicles are taking, we reproduce a view of one of these omnibuses. In practically all other vehicles the gasholders are arranged in much the same manner.

THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

(*Continued from page* 206.)

CONCRETE.

In two other inter-related directions affecting national interests rather than those of a particular trade, it has been possible to make an actual beginning with investigations which it is hoped will have a valuable bearing on conditions certain to arise immediately on the return of peace. As we have already stated, the Concrete Institute is controlling with the aid of the Department a series of carefully regulated tests into concretes made from various selected local aggregates. These researches are being conducted at nine colleges and universities in thirty-six districts throughout the country. We cannot expect the resulting data to be of final value, but in any case the study of concrete and its behaviour under varying conditions will have been begun, and all the knowledge we can now acquire will be useful when the period of reconstruction comes. Working in close intercommunication with the Concrete Institute, a special committee of direction appointed in accordance with our suggestions by the

British Fire Prevention Committee, is carrying out an exhaustive series of tests at the cost of the Department into the fire-resisting properties of different forms of concrete.

GLASS, OPTICAL AND OTHER.

We indicated last year, and the public have learnt to recognise the fact from constant reference to it, that the study of glass in many of its forms is one of serious importance for the national safety. For a short period there was grave anxiety, now happily removed, but we have not relaxed our efforts to deal with this many-sided industry in as comprehensive a manner as possible. The important research at the National Physical Laboratory carried on at the cost of the Department since 1915 has dealt with the fundamental problems of optical glass manufacture. Attention during the past year has been concentrated on the question of refractories. Further progress was also made with investigations into methods of stirring and of melting which shall protect the glass from furnace gases and other sources of contamination in such a way as to leave the molten material freely accessible to stirring and other manipulation. The development of the electric furnace, particularly for the purpose of burning refractories at very high temperatures, proceeded satisfactorily. A new type of resistance furnace was evolved. Heat is generated by contact resistance between specially shaped graphite parts, and an endeavour is being made to substitute pressed carbon similar to that used in arc-lamp electrodes, as the latter can be obtained in this country."* While the National Physical Laboratory has been dealing with the fundamental problems of manufacture, Professor Jackson has been investigating the composition of certain optical glasses for the Department with the assistance of the Glass Research Committee of the Institute of Chemistry. He has succeeded in defining the composition of the batch mixtures necessary for the production of several glasses hitherto manufactured exclusively in Jena, including the famous fluor-crown glass. He has also discovered three completely new glasses with properties hitherto unobtainable. His work upon laboratory and other glasses during the past year has been chiefly devoted to assisting the manufacturers to perfect their processes and to remove difficulties which have arisen in the factories. The Institute Research Committee is beginning the preparation of a reference list of vitreous compounds, their compositions, densities, refractive indices and dispersive powers which, we anticipate, will save the investigator into new glasses much time and labour. The work, one of considerable magnitude, will be carried on in accordance with a scheme prepared by the Research Committee and approved by us.

The Research Institute for Glass at the University of Sheffield, in contemplation when we reported last year, has now been established with the assistance of grants from this Department and from two Associations of Glass Manufacturers. The buildings have been erected and equipped on a larger scale than we then anticipated under an arrangement made by the Ministry of Munitions in consultation with the Committee of Council. The Department have made a grant to the Delegacy of the Research Institute, which includes a capital sum for the provision of special equipment and an annual payment for five years in aid of the cost of maintenance.

New Institute of Technical Optics.—Closely related to problems of glass are those of optics and optical instruments. For that reason we established a single Standing Committee to deal with both subjects. But here, as in every direction, we have found that no sound progress in research is possible without strengthening the bases of our national education. We therefore welcome the untiring perseverance of the London County Council, who have during many years pressed for the establishment of a national Institute of Technical Optics. In the spring of 1916 the Higher Education Sub-Committee of the London County Council put a scheme before the Board of Education, which included the establishment of a new department for post-graduate education and research at the Imperial College, the strengthening of the existing department of technical optics at the Northampton Polytechnic Institute, and the appointment of a single director with a specially constituted committee to supervise the work both at South Kensington and Clerkenwell. The London County Council offered to defray one-quarter of the capital and maintenance charges of the new department at the Imperial College, and have accordingly contributed £1000 a year for maintenance, with a special capital sum of £2500 for alterations and equipment. The scheme appeared to us to be promising, and after conference with the Board of Education, the London County Council and the Imperial College, we recommended your Lordships to make a grant of £750 for special apparatus and an annual maintenance grant of £1000 a year for five years provided the scheme agreed upon at the joint conference was put in force. The Governors of the Imperial College offered the necessary accommodation for the proposed department and later voted a sum of £2000 for equipment. After further negotiation with the Governors of the Northampton Polytechnic Institute and with the Board of Scientific Societies which had interested itself in the project, the scheme was adopted by all the bodies immediately concerned.

New Series of Optical Text-books.—With a due regard to the needs of the industry and of research students in technical optics, our Glass and Optical Instruments Committee have called our attention to the deficiency of books in the English language on geometrical and technical optics. They recommend that a series of foreign works on these subjects should be translated and published with corrections and additions, a proposal strongly supported by the Ministry of Munitions.

We think this short account of the first steps taken towards the establishment of systematic education and research for the industries of optical glass and instrument making justifies us in anticipating the successful development of the plan of operations which we have in view for the future. We have throughout had the advantage of the constant advice and support of the Ministry of Munitions as well as of the firms in the industry who are co-operating whole-heartedly in the scheme.

The Ministry of Munitions and the firms concerned have also co-operated with the Department in a series of experiments intended to remove the difficulties experienced by English manufacturers of X-ray bulbs.

* Report of National Physical Laboratory, 1916-17, page 63.

SURVEYS OF THE FIELDS FOR RESEARCH.

Besides the initiation and direct conduct of researches which from their nature are unsuitable for private enterprise and unlikely to be undertaken on a co-operative basis, we recognise that it will be a permanent and important part of our duties to arrange for surveys to be made of existing scientific knowledge and the fields for research in particular industries. Systematic surveys of this kind are needed in many directions, and we are arranging for their production as rapidly as circumstances will permit. We have already referred to the survey of the field of research in coal which was prepared for our own use before the establishment of the Fuel Research Board. We have had similar surveys prepared on other subjects engaging our attention with a view to future action. Some of these have been or will be published. Among the former is a Report on the Resources and Production of Iron and other Metalliferous Ores, prepared by Mr. G. C. Lloyd, secretary to the Iron and Steel Institute, the first edition of which is already nearly exhausted. The document was prepared on the advice of the Ferrous Section of our Standing Committee on Metallurgy. A Sub-Committee of the Section were unanimously of the opinion that a statistical survey of the supply of raw material for the iron and steel industry should be put in hand as soon as possible, and should be carried on with expedition as a necessary preliminary to research into the constitution of newly discovered materials and the best methods of using them. It is not pretended that this first rapid compilation can be complete or free from error in its earlier editions, but we hope that as corrections and additions are made, it may gradually reach in its later issues a high degree of accuracy. The new edition now in preparation will include a number of corrections and alterations, as well as the available information regarding the metalliferous ores of those countries which were omitted from the first issue. Meantime, we believe that this first attempt at making the information contained in British publications easily available cannot fail to be useful.

The same section of the Standing Committee on Metallurgy have entrusted the preparation of a survey of the field for research in tungsten to a Sub-Committee under the chairmanship of Sir Robert Hadfield.

On the advice of the non-ferrous section of our Standing Committee on Metallurgy we have also appointed a Committee consisting of members of the Institution of Mining and Metallurgy, of the Institute of Metals, of the Engineering Standards Committee, and of the industries concerned to prepare for us two surveys giving the existing knowledge and practice, so far as these can be ascertained, as to the zinc industry and as to the smelting and refining of copper and the qualities of copper and the copper alloys. We are entrusting to this Committee as an interim arrangement, pending the establishment of an association for research into the non-ferrous alloys, the direction of a research into the best method of making sound castings of copper and brass. The Brass and Copper Tube Association have offered a contribution of £1000 towards the cost of this investigation, and we have recommended the Council to make an equal contribution without prejudice to the amount of any grant that may be made to any research association for non-ferrous alloys that may later be established.

We have asked a Special Committee of the Standing Committee on Engineering to prepare a memorandum on the field for research into lubricants and lubrication, with an analysis of the problems involved, and a suggested scheme of research. The Special Committee have submitted an interim report, recommending the compilation of a bibliography on the physical, chemical, and engineering aspects of lubricants and lubrication, and the preparation of abstracts of selected researches of importance, preparatory to the critical review of existing knowledge on the subject and the formulation of plans and estimates for new researches.

We have also offered a grant to the Bradford Association for Engineering Research towards the cost of preparing a survey of the field for research into the flow of steam in pipes.

SURVEYS OF RESOURCES.

Although the survey of promising fields for research and the documentation of existing information are necessary preliminaries to new work and fall consequently within our province, it is otherwise with the survey of what we may perhaps call natural phenomena and resources. Geological survey, both economic and scientific, geodesy, oceanographical survey and the related fisheries survey, meteorology, the survey of biological products of all kinds, even the survey of population of which the census is a part, are distinct from, though complementary to, our activities; yet they must be adequately organised and carried out if our own work is to be adequately done. We referred to some of this work in our report of last year, when we emphasised the importance of a systematic survey of the mineral and other resources of the Empire, and expressed the hope that this matter might be considered by the Committee appointed by the Prime Minister to consider our trade and industrial policy after the war. We sincerely hope that any plans that may ultimately be adopted will include means for collecting information as to all the resources of the Empire, and that whatever Department may be entrusted with the investigation and recording of our national resources will be limited to the establishment of scientific facts and to rendering them available for use by the other agencies interested in, or affected by, the development of the resources disclosed. Our experience has convinced us of the necessity of keeping scientific research clear from the entanglements that arise over the commercial exploitation of discoveries or the routine administration of matters directly affecting capital, labour, public health, or other national services.

Had an organisation adequately equipped for the work already been in existence, we certainly should not have undertaken the preparation of the survey of the metalliferous ores to which we refer above, and the scope of our proposed surveys of the zinc and copper industries would at least have been brought within narrower limits. As it is, we have been obliged, because the necessary foundations of our own work were non-existent, to undertake this work with imperfect means, and with the certainty that some errors and omissions were unavoidable.

FIRST NUMBER OF "SCIENCE AND INDUSTRY."

On the other hand, the publication of the first number of "Science and Industry" marks the beginning of work which we expect to be a permanent part of our activities. The series is intended to record the progress made at home and abroad in the application of science to manufacture, and to include papers that discuss the many problems of training, organisation, and procedure involved in successful industrial research. It opens with Mr. A. P. M. Fleming's account of the provision made for industrial research by public institutions and manufacturing firms in the United States of America. Had it not been for the shortage of paper and other difficulties, we should have issued other numbers during the past year; as it is, we think that Mr. Fleming's report will help us to realise the scale on which research must be undertaken if it is to ensure a due financial return.

DEPARTMENTAL BULLETINS.

We have also begun the issue of a series of "Bulletins" intended to convey scientific information, useful to the industries of the country and based upon research work undertaken at the public cost. The first "Bulletin" is a "Memorandum on the Means to be Adopted to Diminish the Decay of Timber in Coal Mines," which will be circulated to the mine-owners concerned by the Controller of Coal Mines.

NEW STANDING COMMITTEES.

It is not our intention to devote many lines of our report this year to departmental machinery. Provided the machine functions well, the details of its construction have little interest beyond the walls of the Department itself. But we cannot omit to place on record our appreciation of the generous labours of our Standing Committees and of the many Special Committees selected from their membership and from other men of science, that have assisted us in dealing with the applications for aid we have received. In the autumn of last year we established a new Standing Committee for Glass and Optical Instruments under the chairmanship of Professor Herbert Jackson, F.R.S. The Ministry of Munitions represented to us the urgent need for strengthening these industries, and having regard to their close inter-connection we thought it best to set up a single Committee to deal with the research problems that had arisen and were likely to arise. The Committee has been exceedingly active ever since, and has already presented an elaborate preliminary report upon the field for research which has led to the action we have already recorded.

As the result of representations made to us by the Society of Illuminating Engineers, we have also appointed a joint Sub-Committee of our Standing Committees on Engineering and on Glass and Optical Instruments, together with certain co-opted members from the Society of Illuminating Engineers. We have asked this Sub-Committee to make a survey of the field for research in illuminating engineering.

(To be continued.)

GERMAN NAVAL MINES.

THAT Germany would make free use of naval mines in case of war was confidently anticipated by those who were cognisant of her technical preparations. Her naval authorities were deeply impressed by the *rôle* of the mine in the Russo-Japanese War, and a special "mining section" was established at Cuxhaven in 1905. At the same time two fast vessels were designed exclusively for mine-laying, the Nautilus and Albatross, of 1950 and 2200 tons respectively and 20 knots speed. In addition, a few old cruisers were fitted out for the same work. The *personnel* employed in this branch of naval activity was very highly trained. A number of derelict Russian mines was picked up by a German cruiser at the close of the Russo-Japanese War and forwarded to Germany, where, to the astonishment of Admiralty experts, they were found to be much superior to the standard mine then used in the German fleet. This original Russian model was considerably modified and improved in course of time, but its essential features were retained, and are still to be seen in the German mine of the present day. According to a description in the *Journal of the United States Artillery*, the conspicuous features of this mine are as follows:—(1) Mooring-rope reel on the mine, (2) primary battery in inactive condition in the mine, (3) electric battery electrolyte in a sealed glass bottle. The buoyant mine is attached to the anchor by a device locked with a sal-ammoniac plug. The mine and anchor are dropped overboard together, and both sink to the bottom, but when sinking the buoyancy of the mine breaks the fall of the anchor and thus ensures that the latter comes to rest in such a way as to give it the greatest possible holding power. The reel containing the mooring cable is fixed to the mine. When the sal-ammoniac plug dissolves the mine is released from the anchor, and a part of the firing circuit is closed. The ascent of the mine is regulated by a brake on the reel, and when it has reached the proper depth below the surface the decrease in the hydrostatic pressure releases a contrivance on the mine which clamps the mooring cable to the mine, thus keeping it at the required depth. The average depth at which it is sought to plant the mine is 10ft., and the mechanism will operate within an error of ± 2ft. Explosion is effected by electricity. The battery plates are dry, and the electrolyte is held in a sealed glass bottle. Several contact pins, or "whiskers," about 5in. in length, protrude from the mine case. When one of these protuberances is struck by a passing vessel the shock is communicated to the glass flask and shatters it, allowing the electrolyte to run down and energise the battery. The firing circuit being closed, the electric current fires the detonator and explodes the charge. A slight delay is thus obtained between the actual impact of the ship against the mine and the subsequent explosion.

According to Rule VIII., Article I., Par. 2, of the Hague Convention, 1907, "It is forbidden to lay anchored automatic contact mines which do not become harmless as soon as they have broken loose from their moorings." To comply with this condition, the device on the German mine, which clamps the mooring rope, is released when the tension on the latter is removed, and as the same device contains part of the firing circuit, the latter is opened when the tension on the mooring rope is relaxed. A mine constructed on this system should, therefore, become harmless immediately the mooring cable parts, since the firing circuit is opened. Nevertheless, it deserves to be stated that a great many derelict mines of German origin have been encountered in which through inadvertence or of deliberate purpose, the safety device was out of order, making the machine just as dangerous to passing vessels as when it was properly moored below the surface.

As a rule, naval contact mines of the defensive type are linked up by a series cable connecting the anchors of a string of mines, so that by hauling in the series cable the anchors are raised in succession, and the mines rise to the surface, where they can be recovered. In heavy weather this operation is very dangerous. The Germans have evolved a system of raising the mines which eliminates most of the danger. The anchors are connected by a tripping cable, a pull on which releases a bight in the mooring cable and allows the mine to come to the surface in a harmless condition, as the relaxation of the tension opens the circuit. As a further precaution in lifting the mine from the surface a loop of wire in the firing circuit is placed in a convenient position on the exterior of the mine. This loop is cut with a pair of pliers before the mine itself is touched, thus rendering the machine perfectly safe to handle. The type of mine here described is considered to possess several marked advantages over the Elia and Sautter-Harlé models, which are used in many navies. It can always be relied upon to act in a proper manner, as the tumbling of the anchor and imperfect operation of the distance weight are eliminated. It may be cast into the water upside down, but will still adjust itself, and be in perfect working condition. It is as effective in shallow water as in deep, whereas most of the other types are unreliable in water less than 25ft. in depth. The mooring arrangement is so well designed that it is practically impossible for the mine to break loose. The anchor is very heavy, and the dragging of the anchor will not release the mooring cable. By the use of the tripping cable mines can be raised with perfect safety. When in position they cannot be displaced or exploded by the action of the waves or by counter-mining. As the mooring cable reel is attached to the mine instead of to the anchor, more time is available for the automatic submergence device to come into operation, and its efficiency is thus increased. The working of the device is not affected by the speed of the mine-laying vessel or by the condition of the sea surface. The electrical features of the mine resemble those of the Russian type, from which it was evolved. In the Russian mine the contact horns, or fingers, are composed of glass tube, containing a chlorate of potash mixture, enclosed in a lead tube, over which is screwed a brass safety cylinder. Before the mine is planted this cylinder is removed. Inside the case, and directly beneath each tube, is a thin brass cylinder closed by a piece of wood. This cylinder contains several pieces of zinc and carbon arranged in the form of a battery, the zinc and carbon wires being led through the piece of wood. The copper cylinder holds a priming charge of gunpowder and a detonating fuse, the terminals of which are connected to two insulated wires, the first of these being led to the filling hole and connected on the inside to five zinc wires. Each zinc wire is attached to one end of a safety arrangement, the other end of which is connected to five carbon wires. Before laying the mine the brass tubes are removed, leaving the lead tubes exposed. When the mine is struck with sufficient force to crush any one of the lead tubes, the chlorate of potash mixture falls upon the zinc and carbon pieces, thus making a battery, which produces a current and explodes the mine.

ELECTRIC DRIVE FOR WARSHIPS.

IN the course of an article on the turbine electric equipment of the United States 180,000 H.P. cruisers, Mr. W. L. R. Emmett says :—We are in a position to make a comparison which constitutes one of the most important advantages of electric drive. In the geared equipment each shaft has a system of turbines, gears, bearings, thrust balancing devices, and lubricating systems, all mechanically locked together. With high-speed machinery any kind of trouble with any of these parts will almost certainly necessitate the immediate stoppage of the whole system. To keep a high-speed turbine running out of balance or with bearing trouble is impossible, and the gearing part would present almost equal difficulty. In the event of mechanical trouble of such character, a ship would have to be stopped until the wreck could be cleared. The work necessary to uncouple and disconnect any part of such very heavy apparatus would be a serious matter, involving much time, including that required to stop the ship. After the disconnection was made, the idle propeller would act as a very serious drag on a fast vessel.

In the electrically-driven ship there is no mechanical connection of the shaft to anything but the rotors of the motors. These are self-contained ironclad structures, and cannot by any possibility be subject to mechanical interference. The shafts are subject to the same possibilities of bearing or thrust trouble as shafts in other ships, but the presence of the motors does not increase this danger, and the speed being low, it is remote in any case. With this equipment any motor, generator, or turbine, if in any kind of trouble, can be instantly disconnected without stopping the ship, and with only a small loss from the highest speed capacity.

Interchangeability.—Such interchangeability as this power of disconnection gives constitutes one of the most important advantages of electric drive in such a ship. With one motor out of eight in trouble, only one-eighth of the maximum capacity is lost, and the ship's maximum speed is impaired by only about one knot. If a generator or turbine is in trouble, the maximum speed is reduced only about 2 knots. With two generating units and four motors out the ship can make 26 knots, and with three generators and four motors out she can make 19 knots. If parts give trouble, they are simply cut out and repaired at leisure, or as opportunity affords. The value of this interchangeability in a warship can hardly be over-estimated; it largely overcomes the military danger incident to accidents to the driving power, a danger which has always been of primary importance.

Backing Power.—In turbine-driven ships, not electric, it is necessary to provide backing turbines which must run idle in the reverse direction when the ship is going ahead. These backing turbines involve complications which are very objectionable, and if these are reduced to a desirable minimum, the backing power will be greatly inferior to that easily provided with electric drive. Experiment has shown that a turbine forced in an opposite direction involves about seven times as much friction loss as when driven in its normal direction. This loss is very appreciable in the backing turbines of ships and causes heating, which must be dissipated by circulating steam, which causes further loss and waste. There are also serious difficulties and dangers in high-speed apparatus incident to the abrupt and wide changes of temperature where steam is suddenly admitted to a cold reversing turbine. Steam which expands without doing work has a high temperature, and if work is done upon it by a reversed turbine, the heat is considerably increased. With superheat these temperatures may be extreme, and they affect the main turbine as well as the other, since it also must be used for reversal of direction, and since the two often occupy the same casing. The mechanical effect of such abrupt change of steam temperature upon fragile structures presenting very extended surfaces is a matter which has been little considered, but which has caused much serious trouble. With the electric drive the turbine never need be stopped when the ship is under way, and its operation is easier than in a power station, because the load is steadier. With modern high-speed turbines, superheat affords large gains in fuel economy, and the ability to use safely high degrees of superheat may constitute one of the important reasons for adopting the electric drive.

Efficiency of Transmission.—Various statements and estimates have been published concerning losses in high-speed gearing, for which the authority is not known by the writer. Tests at Schenectady have shown losses about double those generally estimated, with rapid diminution of efficiency as load falls. These tests were of a most accurate character, with large smooth-running gears and by the motor generator method, where losses alone were measured, the same power being transmitted with and without the gearing.

With the electric drive in these battle cruisers the losses from turbine to propeller shaft at full speed will amount to 7 per cent., and by adjustment of voltage the transmission efficiency can be kept equally good at all speeds. Considering gearing losses, reversing turbine losses, losses incident to necessary sub-divisions of the turbine and additional packings, it is believed that the actual transmission from turbine blades to shaft at full speed cannot be made more than 2 per cent. better in the geared equipment than it is in the electric. At reduced loads the geared equipment will be much less efficient. The normal cruising speed of these ships will require less than one-tenth of full load, and the drag of gearing, bearings, reversing turbines, and idle parts of main turbines will be very serious. Some of these matters seem to have been ignored in statements which have recently been made on the subject.

Cruising Economy.—With the electric design the number of motors and turbines used can be adapted to the demand for power, while with the other all parts must be kept running. This gives a very important gain in economy at all speeds below the maximum. At 19 knots only one turbine is required to drive the ship, and electrical arrangements are made by which it can be run at full speed instead of running at half-speed, as it would if the ratio were fixed as by gearing. Thus the steam efficiency at 19 knots, a desirable cruising speed, is equal to the best attainable at any speed. Assertions which have been made by shipbuilders and others that equal cruising results can be obtained by the use of cruising turbines are obviously absurd. The cruising turbines themselves would be greatly inferior to the single main turbine so used, and they would be burdened with all the drags which are mentioned above. Cruising economy gives increased cruising radius without renewal of fuel supply. This has always been considered a matter of the greatest importance in warships; it is a feature in respect to which electric drive can have no rival.

AMERICAN IRON TRADE.

THERE has been a remarkable change in the position of the American iron and steel trades since the outbreak of war, and a review of the development of the situation contained in a bulletin, issued under the authority of the United States Geological Survey, contains a good deal of interesting matter.

It is pointed out that during the whole of 1914 prices were low, there was little domestic or foreign demand for iron and steel, and many companies could have saved money by closing their mines and furnaces. The first effect of the European War was still further to discourage the buying of iron and steel products, and it was not until the middle of 1915 that the trade revived, and, indeed, the average price at blast-furnaces of all grades of pig iron for the full year 1915 was 21 cents lower than the average for 1914. The demand for iron ore in the second half of 1915 met with a ready response, there being an increase in shipment from the Lake Superior district of nearly 45 per cent. In the following year the heavy movement of ore began as soon as navigation opened, and the total shipments from the United States in that year amounted to 77,870,553 tons, an increase for the whole country of about 40 per cent. Throughout 1916 there was extraordinary activity in the iron and steel industries. The total production of pig iron was 39½ million gross tons, compared with 30 million tons in 1915. The general average prices of iron ore per ton rose from 1.83 dollars in 1915 to 2.34 dollars in 1916. With regard to the iron ore situation, it is stated by the Geological Survey that the reserves in the United States are so vast that mining operations can readily respond to increased demand, while new discoveries of ore have practically kept pace with production. At present the chief limitations to output in the Lake Superior region are those imposed by shortage of labour and transportation facilities.

At the outbreak of war the iron and steel industry was, as already indicated, in the position of possessing a manufacturing capacity largely in excess of requirements. The steel-making capacity at the beginning of 1915 is estimated at 37,500,000 tons, and on January 1st, 1917, at 43,000,000 tons. It is expected that by January next it will amount to 48,000,000 tons, representing an increase in three years of 28 per cent. The increase in capacity for the production of basic steel is larger than for that made by the acid process. There has been a concurrent increase in the capacity for the production of pig iron, which at the commencement of the present year was equal to 40,000,000 tons per annum. Special efforts are being directed to close the gap between steel making and pig iron producing capacity, which was becoming too wide. Even making allowance for the increase in capacity achieved and contemplated, it is not considered likely that it will be large enough to fill orders promptly. The present high prices are sufficient indication that the manufacturing output of the country is wholly absorbed. As to still further expansion, there are, of course, limitations other than the demand for iron and steel. The capital involved is so great that the future has to be taken seriously into consideration under normal circumstances in planning new plants or additions to existing establishments.

Wartime demands and prices have encouraged increases in plant capacity, irrespective of the consideration whether or not they might prove excessive after the war, and there is, undoubtedly, a belief that a demand heavier than normal after the war is assured. There are, however, other factors which may affect the manufacturing capacity even if equipment has been expanded to the necessary point. The chief of these are limitation of supplies of coke and other fuel and of ore due to insufficiency of transportation facilities and of labour, and shortage of labour at the steel mills. Even granting that the capacity for making crude metals is sufficient, a difficult problem will be the ability to make the special articles used in warfare while supplying the industries expanded by war demands.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"AN EARLY STEAMBOAT."

SIR,—In your issue of July 27th, you reproduce a drawing of "An Early Steamboat," designed by John W. Rastrick in the year of 1813, and in your comments upon same, ask for information as to whether this boat was constructed. I have searched for some information upon this point, but have not been successful. The only clue that I find is that in the year 1814 J. Rastrick, Bridgenorth, took out a patent for "certain improvements." These improvements may possibly relate to the engine he shows on his drawing. Regarding Trevithick, and your quotation from his letter, dated November 13th, 1915, respecting a towing engine, which you assume was meant to drive a screw propeller, I find that in 1815 R. Trevithick, Camborne, took out patents for "Improved Piston and Rotative Engine." According to Elijah Galloway, in his "History of the Steam Engine," published in 1827, "Trevithick, in his patents of 1815, also described three other improvements on the high-pressure engine, the latter of which, though only applied to nautical purposes, is by far the most important. It consists in employing a spiral worm or screw, similar to the vanes of a smoke-jack, which, being made to revolve at the head or stern of the vessel, produces the required motion."

In the same issue of THE ENGINEER, you state that "Trevithick could not be regarded as the pioneer" of the steamboat, as Fulton's Clermont was completed in 1807, and Robertson's Comet in 1812. In your issue of August 10th, Mr. Lee disputes this, so perhaps it may be of interest to you if I quote "The History of the Steam Engine," 1827, Chap. V., on the origin of the steamboat. Galloway says: "Our history is now brought down to the time in which the minds of ingenious mechanics were actively engaged in the project of applying steam to propelling vessels. The idea had, as we have shown, been entertained both by Savery and Hulls in 1736, the latter of whom obtained a patent for the application of the crank to Newcomen's engine, with the expectation of carrying his plan into effect by this means. But the steam engine was of that date too imperfect to admit of success." . . . "Who the person was that made the first attempt to carry into effect this most important improvement has, like most such meritorious inventions, become the subject of dispute.

"It appears that the earliest experiments tried in England were in 1801, but if we may credit the statements of a most ingenious mechanic, Mr. John Evans, of America, it appears he had published a description of a method of driving boats by steam in 1785. Untoward circumstances prevented Mr. Evans from carrying his plan into effect until 1804; but he does, in our opinion, fully establish his claim to the first contrivance of a practicable steamboat. We shall insert Mr. Evans' own account of the commencement and progress of his ideas and experiments, as we consider them sufficiently important to merit every publicity."

I will now give you an interesting extract from Mr. Evans' letter.

"In the year 1804, I constructed at my works, situated a mile and a-half from the water, by order of the Board of Health of the City of Philadelphia, a machine for cleansing docks. It consisted of a large flat or lighter, with a steam engine of the power of five horses on board, to work machinery to raise the mud into lighters. This was a fine opportunity to show the public that my engine could propel both land and water carriages, and I resolved to do it. When the work was finished, I put wheels under it, and though it was equal in weight to 200 barrels of flour, and the wheels were fixed on wooden axle-trees for this temporary purpose in a very rough manner, and attended with great friction, of course, yet with this small engine I transported my great burthen to the Schuylkill with ease; and when it was launched into the water I fixed a paddle-wheel at the stern, and drove it down the Schuylkill to the Delaware, and up the Delaware to the City leaving all the vessels going up behind me, at least, half way, the wind being ahead."

I trust this information will be of sufficient interest to merit insertion in your valued space. FRED. WALSH.

Oswaldtwistle, September 10th.

P.S.—I have a reproduction of Messrs. Trevithick and Vivian's high-pressure engine, patented 1802, with a detailed description of same. The similarity in principle of this engine and the Rastrick engine, shown on the drawing, appears to be the same, the only difference apparently being in the design of the boiler.—F. W.

RAILWAY MATTERS.

THE Canadian House of Commons has passed a vote of 25,000,000 dols. for the purchase of new rolling stock for the Government-owned railways.

RECENT cable advices from Australia state that only 36 miles of the East-West trans-continental railway remain to be completed, and that the line will be opened by the end of October.

IN Perth, Western Australia, a large and influential committee has been appointed to formulate a scheme for holding a post-war exhibition to celebrate the opening of the East-West trans-continental railway.

ACCORDING to the *Board of Trade Labour Gazette* for August, there were, in July, 1914, it is estimated, 19,000 females employed in occupations connected with transport, which figure had, by April, 1917, been increased by 62,000.

IT is proposed to build and equip a cottage home to accommodate thirty-two children, as a memorial to Mr. J. T. Lewis, formerly the chief engineer of the South Indian Railway, who was killed in action in Gallipoli two years ago.

AT the last session of the Tennessee Legislature, a law was enacted which provides that drivers of motor cars shall stop within 50ft. of all railroad crossings unprotected by watchmen or gates, and that they shall also look and listen before proceeding.

THE Inspector of Factories in the Punjaub, Delhi, and North-West Provinces reports an increase of 2000 in the average number of workpeople employed. This is said to be partly due to a large staff required for shell-making and other munition work in railway shops.

THE Midland Railway Company has just completed, for use in France, an ambulance train of sixteen coaches, 961ft. in length, exclusive of the engine, weighing, in running order, 430 tons, and capable of carrying 500 persons. The train has been completed in fifteen weeks.

THE case of a passenger having recently been fined for attempting to enter a train of the London Electric Railways whilst it was in motion, has drawn attention to the fact that in 1915 47 passengers were killed and 1271 injured through falling when entering or leaving trains.

FARES on the Metropolitan, Metropolitan District, Central London, City and South London, Great Northern and City, East London, and the three tube railways of the London Electric Railways Company have been increased. The fares on these railways were not advanced when, on January 1st last, those on the trunk lines were.

UP to August 14th the casualties among the staff of the London and North-Western Railway Company serving with the naval and military forces were :—Killed in action, drowned, &c., 951 ; died from wounds, 470 ; missing, and presumed dead, 177 ; missing, 93 ; wounded, sick, &c., 5061 ; prisoners of war, 208 ; total casualties, 6960.

THE demand for home-manufactured material, owing to war conditions, has given a marked impetus to the activities of the Union Steel Corporation of South Africa, and that concern is turning out 30 lb. rails in large quantities. Various enlargements of the works, with a view to the expansion of the industry, are being considered.

A CONFERENCE between the Irish Railway Executive Committee and representatives of the National Union of Railwaymen was concluded on Saturday last. It has been agreed to increase the amount of the Irish railwaymen's war bonus to 15s. per week, and to convert this into standing wages. The men are, therefore, now on the same basis as those on the British railways.

AN exhibition of fruit, flowers, and vegetables, grown by the allotment-holders employed by the London and South-Western Railway Company, was recently held, the profits from which, and many of the exhibits, went to the company's Railway Servants' Orphanage at Woking. Sir William Portal, in opening the exhibition, said that there were 6000 allotment-holders on various parts of the London and South-Western system.

ARRANGEMENTS have been made between the Metropolitan and Metropolitan District Railway Companies, whereby passengers from certain stations may travel either by eastbound or westbound trains, instead of by eastbound only or westbound only, as routed by the tickets. Passengers from St. James' Park to Great Portland-street or Euston-square, for instance, have hitherto had to travel *viâ* High-street, Kensington, but now have the alternative of journeying by Aldgate.

ACCORDING to the railway returns for 1913—the last published in a complete form—there were in England and Wales 77 railway companies working railways, seven in Scotland, and twenty-three in Ireland. There were also sixty-eight in England and Wales, nineteen in Scotland, and thirteen in Ireland, whose railways were worked by other companies, and in England and Wales seventy-six railways or joint committees which owned rolling-stock, eight in Scotland, and twenty-three in Ireland.

A PROPOSAL that is meeting with considerable opposition in Germany is the increase of 20 per cent. in all second, third, and fourth class fares, and of 14 per cent. in the first-class. The demurrage charges on wagons are now three marks for the first twenty-four hours, instead of two marks, and six and eight marks respectively for the second and third periods of twenty-four hours. Additional charges are proposed on consignment notes and for weighing, disinfecting, and other services.

IN the September issue of the *London and North-Western Railway Gazette* is an interesting article by that railway veteran, Mr. George P. Neele—now over 90 years of age—the late Superintendent of the London and North-Western Railway. Speaking of the train service between England and Scotland, he says that the term "Limited Mail," was due to the passenger accommodation being limited to three coaches—one for Perth, one for Glasgow, and one for Edinburgh. Passengers holding return tickets were not allowed to travel thereby, nor were the directors' gold passes available. If any of the officers of the company had to travel by it they had to book like ordinary passengers. The restriction as to return tickets was withdrawn in August, 1860.

NOTES AND MEMORANDA.

THE best temperature for the electrolytic production of chlorine is from 25 deg. to 28 deg. Cent.

WIRELESS messages are said to have been recently picked up over the record distance of 11,500 miles by the American steamer Sonoma, from the German station at Eilvese.

THE length of an ordinary flash of lightning has been found by Mr. C. G. T. Wilson at Cambridge to be about six miles, and the quantity of electricity passed about 30 coulombs.

THE question of the best metal for making the screw shafts for wooden vessels will soon be raised by the decision of the American shipbuilders to construct a large number of these ships.

THE *Electrical News* of Canada announces that the largest submarine cable in the world has just been completed across Raritan Bay between Eltingville, Staten Island and Keansburg, N.J., by the New York Telephone Company. It is nearly 5¼ miles long, and contains 74 pairs of wires. The new cable does away with 3000 miles of open wires and 13,000 cross-arms used on the old land route. There are longer cables in existence across the English Channel and the Pacific Coast, but these carry only up to sixteen pairs of wires.

AN electrolytic process of deoxidisation has, it is stated in the *Scientific American*, been patented in the United States. The object to be treated is made the cathode in an electrolyte containing phosphoric acid. In addition to its normal function of carrying the current, this acid acts as a solvent upon rust without attacking the steel or iron body beneath. It is in this last detail that its chief availability lies, since nitric, sulphuric, or hydrochloric acid would not display such moderation. Finally, the phosphoric acid is beneficial in preventing subsequent further rusting. The electrolyte is made by adding 10 parts of phosphoric acid to 90 parts of water, or by adding 10 per cent. of the acid to a 10 per cent. solution of sodium phosphate.

A FISHING boat, capable of catching 60,000 lb. of fish in an hour without hook, line, or bait, and then freezing, packing, and canning them, has, says the *Marine Journal* (New York), been designed in America. The principle of the invention is comparable with the method in which a whale gathers its food, namely, by swimming rapidly through the water and keeping its mouth open so as to catch all small fish that come its way. The boat, as designed, pushes before it a huge scoop, while at the same time attracting the fish by powerful searchlights. When the fish have been caught in this manner, a conveyor carries them into the body of the boat, where they are sorted and then transferred by lateral conveyors to the refrigerating and canning room. The inventor claims that this machine, after the first hour's use of the searchlight, will pick up all the fish from a strip two miles wide and 100ft. deep, and that thirty tons can thus be secured in an hour.

THE use of emulsified asphalt for maintaining concrete roads, states the *Building News*, is recommended by a division engineer of the Illinois State Highway Department. This method has the advantage, we learn, that no heating kettle is required, and that the work can be done even when the surface of the pavement is wet, there being no necessity for having the sides of the crack dry in order to make the asphalt adhere to them. About one gallon of emulsified asphalt, thinned with a pint of water, is mixed with a cubic foot of stone chips graded, for large cracks, from three-fourths of an inch down to dust, and for the smaller cracks from a half or three-eighths of an inch down. Small pebbles and sand have also been used with good results. Experience has shown that the aggregate should be so graded as to reduce the voids to a minimum. The asphalt is poured upon the aggregate and the whole thoroughly turned by hand. The mixture is then poured into the crack and well tamped to ensure against settlement.

THE value of the minerals—silver, zinc concentrates copper, tin and coal—exported from New South Wales during the first quarter of 1917, was £2,737,377, an increase of £1,023,123, as compared with the corresponding quarter of 1916. The output from the silver lead mines exhibits an increase of £331,995, and the exports of copper, obtained largely from matte, &c., imported from other States, disclose an advance of 1665 tons, and £391,006 in value. The quantity of zinc concentrates exported also represents a favourable increase in output of 30,016 tons, and of £124,031 in value, but the production of tin declined in value to the extent of £14,384. The coal exports for the first three months of 1917 show a comparative increase of 59,496 tons and £190,475 in value. The gold yield during April was 5214 oz. crude, equal to 4933 oz. fine, valued at £20,956, and showed a decrease of 10,013 oz. fine, and £42,531 in value, compared with April of last year. The value of gold produced during the four months was £116,445, and showed a decrease of 12,295 oz. fine, and £52,226 in value, in the figures for the corresponding period of last year.

THE results of an investigation conducted by the United States Bureau of Mines into the "thiogen" process of sulphur recovery from smelter fumes are briefly summarised in a recent issue of the *Chemical Trade Journal*. In carrying out this process, the gases are first cooled and cleared of all dust and fumes. They are passed through an absorption tower, in which the sulphur dioxide is absorbed in water. To the solution of sulphur dioxide is added powdered barium sulphide, when there is precipitated barium sulphite, thiosulphite, and sulphur. The precipitate is settled, and the mother liquor is returned to the absorption tower. The settled precipitate is then filtered and dried. The elemental sulphur and one-half the sulphur from the thiosulphite are distilled, and the sulphur vapours condensed. The residue, consisting of barium sulphite and sulphate, is then reduced to sulphide, which is returned to the operation as a precipitate. The conclusion is arrived at that in some localities the process can be carried out successfully for the recovery of sulphur and sulphur dioxide in waste smelter gases on a commercial scale, and at a cost of about £2 8s. to £2 12s. per ton of sulphur produced.

MISCELLANEA.

IT is reported that a Canadian company has been formed for the production of potash from felspar under a special process.

ORDERS for aeroplane motors, taken recently by one American firm, include 4500 motors for the United States, 4500 for Canada, and 1000 for England.

IN order to conserve the supply of platinum for military purposes, the jewellers in the United States, actuated by patriotic motives, have decided to abolish jewellery made of this precious metal during the war.

THE Syllabus Committee of the West of Scotland Iron and Steel Institute, finding increasing difficulty in obtaining interesting papers and lectures during the present abnormal times, is inviting members who may have time and material available to put together a few notes on some subject or matter which has come under their notice which they consider may be of interest to the members of the Institute.

THERE is, according to the *Commercial Motor*, a good deal to be said in favour of a scheme that has been approved by the French Chamber, under which large numbers of agricultural motors are apparently to be manufactured as quickly as possible after the war and put at the disposal of farmers on easy terms. The essence of the idea is the supply not only of machines, but of service depôts where they can be maintained and repaired, and where spare parts will be available at a reasonable price. Another feature that is worth noticing, adds our contemporary, is that the scheme encourages a home manufacturing industry in preference to the hurried import of anything that can be got, and puts the products of that industry on to the market in such a way as to give them a reasonable prospect of success.

THE asbestos industry of the United States, the *Chemical Trade Journal* states, is in good condition as to both production and manufacture. The output of raw material is far less than the demand, but the needed supply is readily drawn from Canada. The marketed production of asbestos in the United States in 1916, according to the Geological Survey, was 1479 short tons, valued at £90,000. As compared with the production of 1915, this was a decrease of 252 tons, or nearly 15 per cent., in quantity, but a gain of 482 per cent. in value. The decrease in quantity was wholly in the lower grade. The output of higher grades increased both in quantity and in value.

THE Serbian copper mines, states the *Ironmonger*, are now being intensively exploited by the Germans and Austrians, and further good copper deposits are said to have been found in Poland. Work has recently been begun in the lead and copper deposits of the district of Kielce, and in the neighbourhood of Miedziana, Lysa Gora, and Olkuss the methodical exploitation of these ores has already been started. The existence of copper in this district has long been known, but under Russian rule the deposits were neglected, as the authorities devoted all their attention to the exploitation of the mines in the Urals.

IT is reported in the *English Mechanic* that aeroplane makers in the United States decided some little time back to use metric measurements in conformity with British and French practice. On reconsideration, however, it has been decided that the step would cause delay in the production of the large output contemplated, and the English system will accordingly be used for everything but such items as spark-plug threads. Even the ball bearings are to be based on the English inch, although the metric system has been largely used for these in the past.

STORIES as to the durability of wooden vessels have appeared frequently since the war began. According to an American contemporary, there is still in the Danish merchant fleet a ship, the Constance, which was built at Aeroe in 1723. This vessel had already seen a century's service when the first steamer was built early in the nineteenth century. The Constance, however, according to our authority, is not the only aged merchant vessel sailing under the Danish flag. There are, it is stated, fifteen others, each more than a hundred years old.

IN connection with the proposals for the encouragement of new industries in Portugal, the *Iron and Coal Trades Review* understands that a scheme has been submitted to the Government dealing with the establishment in the country of large iron and steel works to comprise blast-furnaces, a steel-making plant and rolling mills. It is stated that if the Government is prepared to grant the necessary facilities, the applicants will undertake to have running within a period of five years works capable of turning out 100,000 tons of steel ingots per annum.

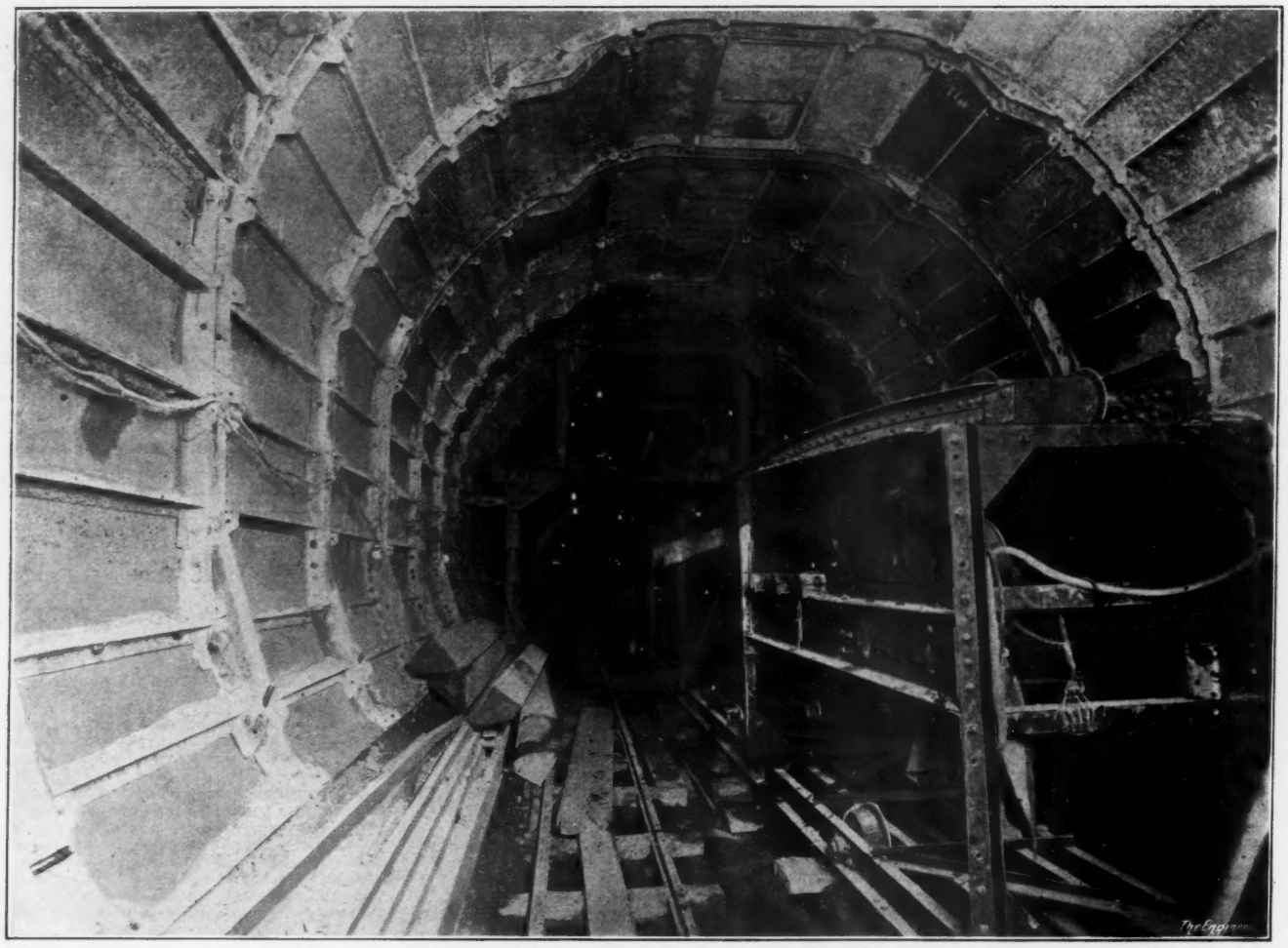
THE *London Gazette* recently announced the appointment of Major-General J. E. Capper, K.C.B., to be director-general of the Tank Corps. This officer, says the *Naval and Military Record*, was born on December 7th, 1861, obtained his commission as lieutenant in the Royal Engineers in July, 1880, and attained the rank of colonel on January 28th, 1906, and major-general on June 3rd, 1915. He served at Tirah in 1897–8, receiving the medal with clasp ; in the South African war, 1899–02 (despatches, Queen's medal with three clasps, and King's medal with two clasps, the brevet of lieut.-colonel, and the C.B.). He was appointed commandant of the Balloon School in 1906, and commandant of the School of Military Engineering in 1911.

FROM Turin to Naples and return without a landing constitutes the world's long-distance aeroplane record, recently established by Captain Julius Laureati, of the Italian service. In an absolutely straight line the two Italian cities are 450 miles apart, but by the route followed, and making allowance for drift, the actual distance covered by the Italian machine was not far short of one thousand miles. Captain Laureati made the trip on a new type of Sia biplane, built in Turin, fitted with a water-cooled engine produced at the Fiat factory in the same city. The time occupied was exactly 10 hours 30 minutes, which gives an average speed of not much less than 90 miles an hour. Although weather conditions were good on the outgoing trip, the aviator had to contend with a head wind and generally unsatisfactory weather conditions on the return journey.

THE DORCHESTER TUNNEL, BOSTON, MASS.

(*For description see page 234*

ELECTRIC TRAIN LEAVING THE AIR LOCK



VIEW SHOWING STEEL FORMS, CONVEYOR, AND TRAVELLER

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TO CORRESPONDENTS.

In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.

INQUIRIES.

SHOP DRINKING FOUNTAINS.

SIR,—We are requiring in our shops a number of drinking fountains for the use of the workmen, and are anxious to install a type which may be used without drinking cups. We know of such a one in the "Puro" Junior Sanitary Drinking Fountain, but shall be glad if any of your readers can refer us to other makers of similar fountains. P. R.

THE ENGINEER.

SEPTEMBER 14, 1917.

Submarine War: The Latest Phase.

IT is characteristic of the amazing progress which science, as applied to the purposes of war, has made within the last three years, that decisive results are now expected from two weapons which, at the beginning of that period, were regarded as mere auxiliaries of problematical value. At the outbreak of the war the aeroplane had scarcely won for itself recognition as a serious military arm, yet at the present time there is a growing tendency, at all events among the Allies, to hail the heavier-than-air machine as the one instrument which can be relied upon to strike the decisive blow. Three years ago the submarine was not esteemed very highly by naval officers as a whole, and comparatively few would have conceded it a degree of utility equal to that of the destroyer. Germany, in particular, showed much hesitation in following the lead of other Powers, and it was not until 1912 that she embarked on a large plan of submarine construction. It is doubtful, indeed, if she had more than thirty of these boats ready in August, 1914. Now, however, the submarine appears to rank before the battleship in the estimation of German statesmen, and they look to it to bring about that peace which daily becomes more necessary to them.

Last week we heard from three different sources noteworthy statements on the submarine war. Admiral Scheer, commander-in-chief of the German Fleet, assured a neutral interviewer that "no one in marine circles entertains the faintest doubt about the ultimate success of the U-boat campaign." Mr. Lloyd George, in his speech at Birkenhead, was no less emphatic to the contrary. "They will not," he said, "be able to beat down the strength of this Empire . . . by means of all the efforts that they can make with their submarines." The third utterance came from a "high naval authority," who gave the public, through Reuter's agency, some additional facts in regard to what is obviously a new phase of the submarine war. For several months now it has been evident that the enemy has submarines in commission with a very extensive cruising radius. This suspicion was verified when certain merchant vessels found themselves attacked in waters far distant from the supposed danger zone. Even a year ago a German submarine crossed the Atlantic and appeared off the New England coast in effective fighting trim after a voyage of at least three thousand miles. Since then it is certain that the enemy has completed submarines of much greater displacement, having a correspondingly enlarged radius of action. The high naval authority quoted by Reuter speaks of these vessels as approximating to cruisers. Reports emanating from neutral sources mention displacements as high as 5000 tons, but this we believe to be an exaggeration. It is probable, however, that some of the latest submersibles are at least half this tonnage, and can carry fuel and other supplies to last for a voyage of five or six thousand miles. No doubt the armament, too, has been strengthened, so that not only in size, but in aggressive power as well, the new German submersibles may be said to resemble the smaller type of cruiser. They no longer depend solely on the torpedo. From the 12-pounders with which the underwater craft of 1914 were armed, the Germans had advanced last year to the 4.1in. gun, and may now be mounting still heavier metal. Provided the displacement is adequate, there is no insuperable difficulty in the way of fitting submarines with guns that would enable them to engage small warships on equal terms. We imagine, however, that considerable ingenuity has had to be expended on the mountings for the larger guns now said to be carried by the raiders. The first gun designed by Krupps for submarine use was a 3.7 cm.—1.45in.—semi-automatic weapon, weighing 5¼ cwt. It was mounted on a fixed pedestal of lenticular section, and, therefore, had to be left exposed when the boat submerged, though the sights, shoulder-piece, and other movable parts were taken below, the muzzle being closed with a tompion and the breech covered with waterproof. The disadvantages of this system were, first, the deleterious action of the sea water on the weapon, and, secondly, the resistance it offered to water passage. A heavier gun, firing a 12 lb. shell and weighing nearly 16 cwt., was also designed. This had a collapsible mounting, so constructed as to reduce to a minimum the time required for bringing the gun into firing position and stowing it below. But with larger guns the mounting problem must become more complicated. If, as is reported, German submersibles now in commission are armed with guns larger than 4in., it is probable that the mounts are of the disappearing type, for the resistance that such bulky weapons on fixed mountings would offer when the vessel was running below the surface would be very prejudicial to speed. The most probable development in the gun armament of submersible craft is, we take it, in the direction of armoured gun-houses or turrets, shaped so as to offer the least possible resistance to passage through the water, and capable of being made water-tight.

With the unlimited data which the Germans by this time must have accumulated in relation to every aspect of submarine tactics, it would be strange, indeed, if they had failed to produce vessels embodying this dearly-bought experience. The more singular, therefore, is the gradual but unquestionable shrinkage in the number of victims they succeed in destroying. People in this country who still take a gloomy view of the submarine position do not, we think, give due consideration to all the facts. To understand the supreme confidence with which Germany's rulers entered upon "ruthless" submarine warfare last January, it is essential to study the prospect as it appeared to them. In the first place, by dint of feverish energy in the shipyards and engineering establishments for many months beforehand, they had succeeded in creating a considerable reserve fleet of submarines. All these boats—perhaps double or treble the total that had previously been in service—were to be thrown suddenly into the scale. Secondly, the prospective victims were to be assailed without any warning whatever, and no distinction was to be made between enemy and neutral ships—in other words, a submarine could sink everything it met, for as no German surface vessels were at sea there could be no possibility of making mistakes. Thirdly, some of the new submarines were of greatly increased size, radius, and aggressive power, and might thus be expected to prove more formidable in every way than their predecessors. Fourthly, the refusal to distinguish between enemies and neutrals gave a pretext for the indiscriminate sowing of mines by submarines specially built for this purpose. Fifthly, released from the Sussex pledge—which, it is true, had never been too scrupulously observed—the raiders might reckon on being able in most cases to deliver their attack from the submerged position, which would greatly reduce their own risks. Other considerations which fortified the German's confidence in the favourable outcome of the new policy, and led them to believe that three or four months would suffice to sweep the ocean highways absolutely clear of shipping might be adduced if space permitted, but those we have enumerated must serve. If we examine them carefully, we shall no longer wonder at the unbounded optimism with which the German nation awaited the result. The introduction of "ruthless" submarining, as distinct from the former policy, was not simply a slight aggravation of what had already been going on for two years. It meant nothing less than a sudden, incalculable multiplication of those perils to navigation which had previously been encountered as a result of the war. Almost every visible factor was in favour of Germany; only history was against her, and there was little to suggest that history, in so far as it concerned the *guerre de course*, would repeat itself. She is learning now, however, that the principles of naval warfare are immutable, and that command of the sea is not to be won solely by attacking the enemy's commerce, even though the aggressive agent is altogether novel and apparently invulnerable.

We do not doubt for a moment that Germany's leaders are by this time fully conscious that the grand coup has failed. For this reason it is impossible to

acquit the commander of the High Sea Fleet of deliberate misrepresentation, when he declares that naval opinion still has faith in the success of the submarine campaign. Certainly naval opinion in no other country shares that faith. The evidence of failure is patent to the world. We notice, however, that even Admiral Scheer abstains from setting a time limit to the endurance of the Allies. Like Marshal von Hindenburg, he contents himself with affirming that we cannot hold out much longer, but he incautiously adds that "even a child" could perceive the impossibility of our holding out for many months in face of the rapid depletion of the tonnage at our disposal. This may sound plausible enough to the German people, who are purposely kept in the dark as to the potential strength of Great Britain and her Allies. It took all of us a long time to realise the gravity of the menace to our sea communications, but the awakening, albeit belated, was not too late, and the record of work performed by our shipbuilders and engineers since the early part of this year would prove most depressing reading for our enemies. No doubt thay have some inkling of what is being accomplished, and are making desperate efforts to nullify it by multiplying the fleet of submarine commerce destroyers. To give a really decisive character to the submarine campaign, it would be necessary to increase very considerably the amount of damage they are now inflicting. We are not allowed to learn a great deal about the work of the anti-submarine organisation, but the results speak for themselves. For several weeks now the average of losses has remained almost constant; certainly it shows no tendency to rise to the admittedly dangerous figure of four months ago. Yet, if we are to credit German assurances, new submarines continue to be launched in ever-growing numbers, while they are being destroyed, so say the Germans, only at the rate of three per month. In other words, more submarines are at work to-day than ever before. In that case, it follows that the individual U-boat is relatively much less dangerous to-day than it was a few months since, for the collective damage caused by the raiders was greater then than it is now. We can afford to view with indifference German attempts to explain away these painful facts. Our task is to see that the work in our shipyards goes steadily on without let or hindrance, for it is there that we are fashioning the keys of victory.

Fuel Alcohol.

A DEPARTMENTAL Committee on Industrial Alcohol, which reported to Parliament in 1905, said "We think that close investigation of the matter may be delayed until such time as there may be an approximation between the prices of petrol and spirit sufficient to create a practical choice between the two." With these words the Committee thought no doubt it had shelved the whole inconvenient matter, and it certainly did not anticipate that a few years later the position that it had predicted would be realised to the letter, and that alcohol and petrol would be retailed at the same price. The Committee, moreover, was not disingenuous in its use of this argument, for its resistance to desired changes was amongst the very things that would keep the price of alcohol high. It will be said that the position now reached is wholly artificial, and that whilst petrol and alcohol are at about the same price, both are so dear that neither can be freely used. We admit that this is so, but in all likelihood, for many a year after the war, the price of petrol will remain in the neighbourhood of two shillings a gallon, whilst that of methylated spirit *may* be brought down to approximately the same figure. We say may because the price depends in a very large measure upon the will of the people. If the country decides that it must have industrial alcohol on the same terms as France and Germany have it, then it can compel the forces which have ranged themselves against that object to surrender their position. If it is careless or indifferent, if it fails to grasp the fact that this is a question on which the public can speak with as much authority as the expert, and more than Departmental Committees, then it must be prepared to see not only its manufacturing industries hampered by restrictions, but its agricultural industries robbed of an opportunity which fairly belongs to them. As the prosperity of the country must suffer if the conditions that prevailed before the war are allowed to continue after it, we urge upon all the necessity of giving the matter their earnest thought, and particularly advise them to shut their ears to the arguments of the opponents of change, for amongst those arguments there is not a single one that is better than a mere plea for the continuance of the old system, because it would be inconvenient or troublesome to change. Had alcohol been a non-intoxicating liquor it would, we do not hesitate to say, be looked upon in the same light as coal or petroleum, and sold under as few restrictions. It cannot be made non-intoxicating, but it can be made unpotable, and in that condition it should be sold free from all duty and from the restrictions which have hampered alike its manufacture and use.

The facts upon which the public need centre its attention are few and almost non-technical. Statistics we would advise it to avoid. A resolute determination to have what we want is frequently more powerful than a shipload of figures. Alcohol is produced from starch by fermentation. Starch is made in living vegetable matter by the action of sunlight. Its amount is variable. Some plants contain a great deal; others relatively little. Potable alcohol is made from grain, which is poor in starch as measured in yield per acre; industrial alcohol is now made in Germany and France from potatoes and the sugar beet, both of which give a very much greater yield per acre. We do not yet know, and we shall not know till the importance of industrial alcohol is recognised, what other, and even cheaper, sources of starch are available. It has been shown that wood sawdust yields a high percentage of alcohol—50 gallons per ton—and it is probable that the fruits of some of our forest trees, which are now generally allowed to rot on the ground, would prove valuable under fermentation. It is also conceivable that a great deal of vegetable refuse, which now goes to the destructor, could be profitably treated. Indeed, a system for the recovery of alcohol from garbage is already in use in America, and was described in our issue of August 10th, page 130. On these points we can speak with no certainty, because knowledge is lacking. We in this country have never looked upon alcohol as an important fuel, and no one has considered our resources of it with the same care that the resources of coal and oil have been considered. Some day that must be done. "When the great demand for alcohol as a fuel arises," said the late Vivian Lewes some years ago, "it will be found that vegetation in all its forms will, by proper treatment, yield to fermentation, and give us the means of regenerating the solar energy that caused its growth." Alcohol differs from the other fuels in this respect, that the supplies are inexhaustible. Our resources of coal and iron are being used up and relaced by Nature, if replaced at all, at a pace so slow as to be wholly negligible, whereas every hour of sunshine adds enormously to our potential supplies of alcohol. It is the one important fuel and the only one that Nature makes at a humanly reasonable speed. But the consequences of this fact are remote, for the world's supply of coal and oil will last for centuries, and if there were no other consideration alcohol as a fuel would present a far less pressing problem than it does. The consideration to which we refer is, of course, that the country is committed to liquid fuel of a certain kind. It must have an easily vaporisable spirit. The national resources of such spirit are but three in number. They are benzol from coal, a petrol spirit from shale, and alcohol. The first will be available some day in large quantities, but in augmenting price as the easily available coal is exhausted; the second can never amount to more than an almost inappreciable amount; the third depends upon ourselves. If we depart from the folly of the past, revise our alcohol laws, and encourage the manufacture of an industrial spirit, we shall add immeasurably to our resources, delay the exhaustion of the world's supply of coal and oil, decrease in some measure our reliance upon other nations, and give the country a new and valuable industry.

It is on these obvious and incontrovertible facts that the general public should fix its mind. The question of the price of alcohol, as contrasted with that of other fuels, is, we will not say an unimportant, but a secondary matter. The position is precisely the same as that of home grown and foreign grown corn and meat, and just as we must grow more food in this country, so must we make more fuel. The economic problems are almost the same, but that of home grown industrial alcohol is certainly less difficult than that of home grown food, because the quantity of imports can be more easily restricted—there would be no question of interfering with the food of the people. We do not for one moment suggest that all the light liquid fuel the country requires should be supplied in the form of alcohol, nor that the importation of foreign alcohol or petrol should be prohibited. That is far from our intention. It is probable, nay certain, that in tropical and sub-tropical parts of the Empire alcohol can be more cheaply manufactured than in the British Isles, and to exclude it would be folly, but it should not be a difficult matter to arrange that the amount imported did not exceed a certain proportion, say, half at the end of a certain term of years, of the country's whole requirements, so that the actual price would be a mean between the price of the imported and the home made fuel. Furthermore, alcohol will blend perfectly with benzol or petrol, and as an admirable motor spirit results our national resources of benzol would be given a longer life, and by delaying the exhaustion of the world supplies of petrol we should retard the rise in price of that commodity. Of the importance of growing alcohol crops to the agricultural interests of the country we have not left ourselves room to speak, and in any case the subject is somewhat outside our scope, but we can cordially recommend to the attention of our readers a pamphlet written by Mr. Robert N. Tweedy, and issued by the Co-operative Reference Library of Dublin. Mr. Tweedy gives a popular review of the whole subject, and deals particularly with the bright outlook that the growth of alcohol crops presents to Irish agriculture. His views may be a little sanguine, but that is a small matter. Even if the rosy prospect he opens before us can never be attained we can yet get far nearer to it than we have ever done. What is required is a strong public opinion that will overbear the old prejudices and remove the obstacles that have for years hindered a development which would have saved us now, as it has saved Germany, from a serious embarrassment.

THE NICKEL DEPOSITS AND INDUSTRY OF ONTARIO.

No. II.*

THE history of the discovery of nickel in Ontario is interesting and curious. In 1856 the abnormal variation of a provincial surveyor's magnetic compass led to the discovery of an immense mass of "magnetic trap" at a certain point in what is now known as the Sudbury district. This trap on analysis was found to contain magnetic iron ore through which sulphides of nickel and copper were disseminated. The exact point at which this discovery was made is now the site of the Creighton mine, the greatest nickel mine in the whole of Ontario, and, indeed, in the whole of the world. Nevertheless, the discovery was before its time, and was allowed to pass out of mind for many years.

Before the date mentioned, the district bordering the northern shores of Lake Huron had attracted some attention as a source of copper ore, and a certain amount of copper mining had been undertaken. These early undertakings, however, after a few promising years, soon became unprofitable by the working out of the lodes. In 1883, during the construction of the Canadian Pacific Railway through the Sudbury district, a deposit of "copper" ore was exposed in a cutting. The early copper mining activity was, no doubt, recalled, and as soon as the snows cleared in the spring of 1884, a rush of prospectors set in to the district. During that year and the succeeding three many rich discoveries of "copper" ore were made, and, in some cases, mining operations were started. Up to the year 1887 no one regarded the ores of the district as other than of copper. That they were really nickel ores, or, to be quite correct, ores of nickel and copper, was discovered in this year by the chemist of the Orford Copper Company during the smelting of a quantity of ore from the Copper Cliff mine of the Canadian Copper Company.

This discovery of nickel in the ores—that "spirit of the mine" which the old German miners blamed for inciting their copper ores to bad behaviour—was not altogether welcome. First the demand for nickel in those days was very limited, and, secondly, its presence made the recovery of the copper difficult. The New Caledonian ore at this period amply met the world's demand for nickel. Further, unlike the Sudbury ore, it was free from copper. These facts greatly affected the early conditions of the Ontario nickel industry.

To-day the bulk of the mining in the Sudbury district is in the hands of two companies, the Mond Nickel Company, and the International Nickel Company. The former company is, of course, English. The latter was formed in 1902 by the amalgamation of the Canadian Copper Company, the Orford Copper Company, and other bodies. It is incorporated under the laws of New Jersey. Both these companies mine and smelt the ore in the Sudbury area. Each, however, exports the matte to works outside Canada for refining. The Mond Company refines its matte at Clydach, near Swansea. The International Company has its refining works at Bayonne, New Jersey.

Among the other companies engaged in mining operations in the Sudbury area, the British-America Nickel Corporation, Limited, must be mentioned. This company acquired its nickel holdings from the Dominion Nickel-Copper Company, and proposes, not only to mine and smelt the ore in Ontario, but to refine it there. For this purpose it has acquired the North American rights to use the Hybinette electrolytic refining process, which has been for several years in practical operation at the nickel works at Kristianssands, Norway. The company owns, among other mines, the Murray mine, the deposit discovered in 1883 during the construction of the Canadian

* No. I. appeared September 7th.

Pacific Railway. The history of this company is not quite clear, but since its incorporation in 1913, the Imperial Government, it appears, has acquired a controlling interest in it. One of those interested in its promotion was the late Dr. F. S. Pearson, of New York and London, who was engaged in financing it in London, when he was drowned on the Lusitania, in May, 1915. The Imperial Government has made substantial advances in money to the company, and has given it a long term contract for a large annual supply of nickel. The Krisstianssands Nikkelraffineringsverke is also a shareholder in the company; but with this exception, all its stock and securities are held by British subjects. By an Act of the Dominion Parliament, it is provided that the majority of its directors shall be British subjects.

The true position of the world's nickel industry cannot be properly understood, however, without some reference to the conditions controlling the New Caledonian industry. These conditions, as revealed in the Royal Ontario Nickel Commission's report, are, to say the least of it, involved.

It was not until 1904 that the British Government would permit the use of other than New Caledonian nickel in the manufacture of its armour plate, &c., and it only did so then after long and expensive demonstrations by the Mond Nickel Company of the quality of the nickel it produced from the Ontario deposits had been given it. There are, perhaps, some grounds for believing that the Government preference for New Caledonian nickel had a technical basis. As we have already said, this ore is free from copper, whereas all the Canadian nickel ores carry a considerable body of copper, in some cases, indeed, more copper than nickel. The objection to the Ontario nickel may, therefore, have rested on the fear that some copper would get into the steel along with the nickel. That copper, if present, exercised a harmful effect on steel was for long believed by nearly all people, and is still believed by some. The facts are, however, that its effect has been greatly exaggerated, and that, as shown by Dr. J. E. Stead, Professor Arnold, and many others, copper up to 1 per cent. has practically no effect on the steel, while between 1 and 2 per cent. it raises the yield point and tenacity and slightly lowers the elongation and contraction of area. It has further been definitely established that in nickel steel the presence of copper in small amounts is without effect, and, indeed, may be regarded simply as replacing an equivalent amount of the nickel. Apart, however, from this question of the influence of copper in steel, it is to be observed that the nickel extracted by the Mond Company from its Ontario ores has a purity of 99.8 per cent. or higher, the residue being iron and minute quantities of sulphur and carbon. Copper, it seems, is entirely absent.

A study of the commercial aspects of the New Caledonian nickel industry suggests an alternative explanation for the former opposition to Canadian nickel. The leading French producer of New Caledonian nickel ore is Le Société Anonyme le Nickel—generally referred to as "Le Nickel." This strong company is backed financially by the Rothschilds, and has close business connections with the great European armament works. It operates four nickel refineries, one near Glasgow, one near Birmingham, one at Havre, and one at Iserlohn in Westphalia.

The Anglo-French Nickel Company, Limited, with refining works near Swansea, is closely related to Le Nickel. It obtains all its raw material from Le Nickel, while its shares are equally divided between Le Nickel and the leading British armour plate and steel companies.

A third company interested in the New Caledonian nickel industry is the Steel Manufacturers' Nickel Syndicate, Limited, incorporated in 1901. This syndicate has a long term contract with Le Nickel for the supply of all its requirements. Its shares are held in equal parcels of 125 each by the Anglo-French Nickel Company, Vickers Limited, Armstrong, Whitworth and Co., Limited, Fried. Krupp, of Essen, Schneider and Co., of Le Creusot, two other French armament companies, an Austrian company and an Italian company. It will be seen that the shares of this very international company are held in the following manner :—

By French interests ...	437½	By German interests ...	125
By British interests ...	312½	By Austrian interests ...	125
By Italian interests ...	125		
Total	875	Total	250

To what extent the outbreak of war has affected the workings of Le Nickel, the Anglo-French Nickel Company, and the Steel Manufacturers' Nickel Syndicate, we cannot say, but that it must have had a considerable repercussion is obvious. It is gratifying to notice that in all three cases the situation is predominantly in the hands of the Allies.

We will now turn from these historical and commercial matters, and briefly review the technical aspects of the treatment of the Ontario nickel ores. The ores are apparently composed of iron pyrites accompanied by sulphides of copper and nickel, together with quartz, clay, lime, and magnesium oxide. Two typical analyses of the raw ore are given below, the first being for the ore taken from the Creighton mine, and the second for the ore taken from the Crean Hill mine.

Percentage Analysis of Raw Ores.

Cu.	Ni.	Fe.	S.	SiO_2.	Al_2O_3.	CaO.	MgO.
1·4 ...	3·9 ...	39·5 ...	23·0 ...	21·0 ...	5·25 ...	2·5 ...	3·0
2·5 ...	1·75 ...	24·0 ...	11·5 ...	32·0 ...	10·0 ...	5·0 ...	5·5

It will be noticed that there is a considerable variation between the two ores. This is characteristic of the ores from the other mines as well, and leads to the practice of mixing the ores from different mines in judicious proportions before treating them.

The first step adopted is to roast the ores, so as to get rid of as much of the sulphur as possible. This preliminary roasting process is, however, not essential, and has been given up in a number of cases, and is being given up in others. The ore is piled into heaps and its combustion started by means of brushwood. Once started, the pile will continue to burn without addition of fuel for three or four months. At the end of this time, the sulphur content of the ore is reduced by some 50 per cent., through the conversion of the sulphides to sub-sulphides. An improved method of roasting the ores now in some use consists of employing Wedge calcining furnaces. These are capable of treating some 60 to 100 tons of ore per twenty-four hours, and reduce the sulphur to a third of its original amount. In addition, their use permits the sulphur driven off to be employed profitably as in the manufacture of sulphuric acid and sodium sulphate, and of wood pulp by the sulphite process.

The ore, either raw or roasted, or part raw and part roasted, is smelted in a blast-furnace. The mixture of ores can usually be so blended as to be almost self-fluxing. Limestone, however, may be added to increase the fusibility of the slag, while quartz—cupriferous quartz for preference—may be used to assist the oxidation of the iron and sulphur. As a result of the smelting, the quartz, clay, lime and magnesium oxide present in the roasted ore pass off wholly into the slag. A small amount of the nickel, copper and sulphur and a fairly high percentage of the iron, also pass into the slag. About 9 per cent. of the nickel-copper content of the original charge is said to be lost in the slag. Efforts have been directed towards recovering this by passing the slag and matte into settling tanks. When settling is completed, the slag is removed and the rest of the contents—the matte—is tapped into ladles. The matte contains nearly all the nickel and copper, and a goodly proportion of the iron and sulphur of the original charge. A typical analysis of the matte is as follows :—

Percentage Analysis of Matte.

Cu.	Ni.	Fe.	S.
7·35	16·86	45·5	26·0

The aim is to produce a matte containing on the average about 25 per cent. of nickel plus copper. A further degree of concentration than this could be achieved, but it is found that the greater the concentration attained the greater will be the loss of nickel in the slag.

The treatment of fine ore presents some difficulties in the blast-furnace, for it cannot easily be briquetted. To meet this, at least one company has adopted a reverberatory furnace for smelting such fine ores in place of a blast-furnace. The reverberatory furnace is lined with silica bricks, and has a floor of tamped silica sand. It is particularly interesting to note that the furnace is fired with coal dust blown through five burners by a fan. It seems possible that the reverberatory furnace may yet replace the blast-furnace, not only for the fine ores, but for all classes.

The liquid matte tapped from the settling tanks is passed into a Bessemer converter. At first the converters were of the acid type being lined with silicious material rammed into place. Owing to the rapidity with which the slag produced ate into the lining, basic converters lined with magnesite brick have now been extensively, if not exclusively, adopted. The function of the converter is to oxidise the iron in the matte and to cause it to enter into combination with silica to form a slag. In the acid type of converter, the silica was supplied by the furnace lining. In the basic converter quartz or other silicious material is thrown into the converter along with the matte. The operation of these converters is conducted differently from that of Bessemer steel converters. The charge is not simply blown and poured. At the outset a charge of some 70 tons of liquid matte and about 7 tons of silicious flux is placed in the converter. The blast is then turned on for from half to three-quarters of an hour. The slag formed is then poured off, and a further 5 or 6 tons of matte is added, together with about 3 tons of silicious flux. Blowing is then recommenced. This cycle is repeated until about 400 tons of matte and 158 tons of flux have been charged. This is accomplished in about fifty-two hours, at the end of which time there remain in the converter about 117 tons of bessemerised matte. The matte is then cast into slabs ready for export.

The aim of the converting process is to produce a matte from which all the iron has practically been eliminated. It is not desired, however, to remove more than a certain amount of the sulphur, for above a certain point the removal of the sulphur renders the finished matte tough and difficult to break. A typical analysis of converter matte is as follows :—

Percentage Analysis of Converter Matte.

Cu.	Ni.	Fe.	S.	SiO_2.
25·0 ...	53·5 ...	0·4 ...	21·25 ...	0·05

The aim established by practice is to produce a finished matte containing about 80 per cent. of copper plus nickel. In practice this percentage is maintained with great constancy. The relative amounts of copper and nickel making up the 80 per cent., however, vary greatly, being dependent upon the nature of the original ores and the manner in which they are mixed for smelting.

The matte thus produced consists, it will be gathered, almost entirely of a mixture of the sub-sulphides of nickel and copper. The conversion of this into metallic nickel and copper and the separation of the two metals is termed "refining," a use of the word which is not in keeping with its ordinary meaning. It is in this matter of refining the matte that so many of the difficulties, technical and otherwise, experienced by the Ontario nickel industry have lain. In the case of the New Caledonian ores, the nickel is mined not as the sulphide, but as the oxide. It is, however, smelted with sulphur containing materials, and reaches the refining works as the sulphide. The two mattes are therefore identical in this respect. On the other hand, it cannot be denied that the presence of copper in the Canadian matte renders the refining of the nickel considerably more difficult than is the case with the New Caledonian matte. Special methods of carrying out the refining process have had to be evolved for treating the Ontario ore. That the refining of the matte produced in Ontario was not carried out in Canada has been for some time a source of grievance with Canadians. The intention of doing so, announced by the British-America Nickel Corporation, and now, we believe, actively under way, has therefore met with warm approval.

There are three practical methods of refining Ontario nickel matte now in operation. These are the Orford process, the Mond process, and the Hybinette process.

Of these, the Orford process is the oldest. It is in use by the International Nickel Company at its refining works at Bayonne, N.J. It is stated to be cheap to operate, and to permit of a very large output in a confined space. It does not, however, succeed in recovering more than a small proportion of the precious metals, such as gold, platinum, palladium, silver, &c., which nearly always accompany the matte as received from the mines. Full details of the Orford process are not available. It is known, however, that the process depends upon the fact that if a matte consisting of the sulphides of iron, copper, and nickel be fused with sodium sulphide, the product separates into two layers, of which the upper, the more fusible one, contains the double sulphides of sodium and copper and sodium and iron, while the lower contains the greater part of the nickel sulphide present in the original matte. This separation process is repeated several times. The final bottom layer is then ground and roasted with salt in a reverberatory furnace. Any copper remaining in the charge is thus converted to soluble copper chloride and sulphate, while the nickel is converted from the sulphide to insoluble oxide. The product is leached with water. The solution formed contains salts of copper, silver, platinum, palladium, &c., and is treated for the recovery of these metals. The residue of insoluble nickel oxide is converted to metallic nickel in oil-fired reverberatory furnaces. The top layer resulting from the fusion of the original matte with sodium sulphide is leached with water to remove any soluble sodium salts. The insoluble residue is smelted to blister copper. This copper contains some 2½ per cent. of nickel, and a proportion of the precious metals in the original matte. It is sold to the electrolytic refiners of copper, who recover from it, in the course of their work, its nickel and precious metal contents.

The Mond process of "refining" copper-nickel matte is altogether different from the Orford. It depends upon the fact, discovered in 1889, by the late Dr. Ludwig Mond, and two other investigators, that carbon monoxide, passed over metallic nickel at a temperature of 50 deg. Cent., results in the formation of a volatile compound, nickel carbonyl, $Ni(CO)_4$, which, when heated above 150 deg. Cent., decomposes again into metallic nickel and carbon monoxide.

The Bessemer matte, as received at Clydach from Ontario, is first roasted to reduce its sulphur content to about 2 per cent. The roasted material is then leached with sulphuric acid, which dissolves about 70 per cent. of the copper originally present together with 1 or 2 per cent. of the nickel. The undissolved residue is washed, dried, and powdered. The reduction process then follows. This is carried out in vertical towers about 40ft. high, fitted with heating means and with power-driven stirring arms. As the powdered charge descends through the tower, it is brought into contact with an upward moving stream of water gas. The nickel and copper are thus reduced to the metallic form, while the iron present in the original matte is changed from ferric to ferrous oxide. The reduced charge is then transferred to the volatilising towers, which are similar in construction to the reducing towers. The material in its descent meets a rising stream of producer gas at about 50 deg. Cent., the carbon monoxide of which acting on the metallic nickel forms nickel carbonyl. This liquid is at once volatilised, and as a vapour or gas passes off upwards along with the producer gas into the decomposer. About 70 per cent. of the original

nickel is thus removed. The residue is melted and re-treated, and the final residue sold for its precious metal contents.

The nickel carbonyl formed in the volatilising tower is decomposed at a temperature of about 200 deg. Cent. in a mechanical appliance originally charged with shot or granules of nickel. The nickel set free by the decomposition of the carbonyl is deposited on these granules and adds to their size. At the end of about two months, the shot have grown to about ¼in. in diameter, and at the end of six months to about ⅜in. The product is screened and sold in various sizes.

The copper sulphate produced by the preliminary leaching of the roasted matte with sulphuric acid is crystallised and is sold to the vine growers and potato farmers for spraying purposes. The mother liquor remaining from the crystallisation is rich in nickel sulphate, which is crystallised separately.

The Hybinette process of "refining" copper-nickel matte is an electrolytic one. It has been in use at Kristianssands for several years and is being adopted at the Ontario works of the British-America Nickel Corporation. The matte is first roasted and leached with sulphuric acid. The residue containing a reduced quantity of copper is melted and cast into anode plates measuring about 3ft. by 3ft. 6in. by ½in. thick. To recover the nickel, cathodes of iron plates coated with graphite are used, together with an electrolyte containing before the start of the operations 45 grams of nickel, and from 3 to 5 milligrams of copper per litre. Direct current at about 170 volts is used. The process is continued until about ½in. of nickel has been deposited on each side of the cathode plates. The anode slime contains the precious metals and is sold for their recovery. The copper is recovered separately on cathodes of copper sheet.

There are many other matters connected with the nickel industry of Ontario with which, had space permitted, we would like to have dealt. One of especial interest is the direct manufacture of nickel-copper steel from the Sudbury ores, a process viewed very favourably by the Royal Commission. For this and other matters, however, those interested should consult the original report, from which all the information in this and the first article has been extracted.

BOOKS RECEIVED.

The Interpreters. By George Ince. London: Constable and Co., Limited. 1917. 2s. net.

The Elements of Coal Mining. By Daniel Burns. London: Edward Arnold. 1917. 3s. net.

Brazil Commercially Considered. "Syren and Shipping," Limited, 91 and 93, Leadenhall-street, E.C. 5s.

The Munition Workers' Handbook. By Ernest Pull. London: Crosby Lockwood and Son. 1917. 2s. 6d. net.

Oils, Fats, and Waxes. By P. J. Fryer and F. E. Weston. Cambridge, at the University Press. 1917. 9s. net.

Laws of Physical Science. By E. F. Northrup, Ph.D. Philadelphia and London: J. B. Lippincott and Co. 8s. 6d. net.

Jane's All the World's Aircraft. Edited by C. G. Grey. London: Sampson Low, Marston and Company, Limited. 1917. 21s. net.

Royal Ontario Nickel Commission. Report and Appendix, 1917. Toronto: A. T. Wilgress, Printer to the King's Most Excellent Majesty.

Les Etablissements D'Artillerie Belges Pendant la Guerre. By Willy Breton, Berger-Levrault, editeurs, Paris-Nancy. 1917. 6f.

Institution of Mechanical Engineers. January-May, 1917. Published by the Institution, Storey's-gate, St. James' Park, London, S.W. 1.

Watt and the Steam Age. By John W. Grant. London: St. Bride's Press, Limited, 24, Bride-lane, Fleet-street, E.C. 4. 7s. 6d. net. 1917.

The Wonder Book of the Navy. Edited by Harry Golding. Ward, Lock and Co., Limited. London, Melbourne, Toronto. 1917. 3s. 6d. net.

United States Artillery Ammunition. By Ethan Viall. First edition. London: Hill Publishing Co., Limited, 6 and 8, Bouverie-street, E.C. 1917. 8s. 4d. net.

The Universal Directory of Railway Officials, 1917. Compiled by S. R. Blundstone. London: The Directory Publishing Co., Limited, 15, Farringdon-avenue, E.C. 4. 15s.

The Theory of the Submarine Telegraph and Telephone Cable. By H. W. Malcolm. London: "The Electrician" Printing and Publishing Company, Limited, Salisbury-court, Fleet-street, E.C. 4. 18s. net.

Artilleristisch Tijdschrift. (First Year, No. 1. July August, 1917). Edited by J. H. Carstens and J. H. Westerveld, Captains of Artillery. Amsterdam: Van Holkema and Warendorf. Annual subscription 5 florins.

IN the recently published annual report of the Advisory Committee for Aeronautics, it was stated that the investigations on the subject of aeroplane radiators had been brought to a conclusion, and recommendations made for standardisation. Effect has now been given to these conclusions by the Air Board, and a confidential circular letter has been issued to aeroplane contractors and radiator makers, instructing them as to the material which is to be used for this purpose in future designs. Inquiries on the subject may be addressed to the Department of Aeronautical Supplies, Room 609, Air Board Office, Strand, W.C. 2.

SUBMARINE TUNNEL AT BOSTON, MASS.

THE Dorchester Tunnel for the underground system of electric tramways at Boston, Mass., has a length of about 12,000ft., and is mainly at a very shallow depth. For 2200ft., however, it is a deep-level tunnel passing under Fort Point Channel, which is a part of the harbour. This part of the tunnel runs parallel with and under the centre of the channel, with a curved approach at each end. At the north end is an inclined approach, 800ft. long, on a gradient of 1 in 40, while at the south end the inclined approach is 700ft. long, on a gradient of 1 in 33. For 370ft. of this end there are twin tunnels of rectangular section with arched roofs. They were driven by the drift method with the use of compressed air. For the rest of the work there are twin circular tunnels, driven by the aid of shields worked under compressed air.

Work was prosecuted in both directions from a main shaft at the lower end of the south incline, at a short distance from the channel. The shaft is rectangular in plan, 64ft. by 70ft., with its bottom 60ft. below the street surface. It was excavated mainly in blue clay, and was sunk in the open, although very heavy bracing was required to resist the severe earth pressure which developed before the armoured concrete lining could be placed. The chambers for the ends of the tunnels for the erection of the air-locks were also excavated in the open.

The two shields for the parallel circular tunnels are 24ft. 4½in. diameter and 12ft. 6in. long, weighing about 83 tons each, without the jacks. Each shield has twenty-four hydraulic jacks with 8in. plungers and 34in. stroke. The forward end of the deck of the shield is fitted with a sliding extension platform made in two sections, each having two hydraulic jacks with 3½in. plungers. These keep the platform pressed against the earth at the working face, thus providing sufficient support to keep sandy soil from caving, and to prevent excessive flow of the clay. All the jacks work under a maximum pressure of 5000 lb. per square inch. The heads of the main jacks are so shaped as to form a nearly continuous ring, bearing against the outer timber shell or lining which takes the thrust when the jacks are forcing the shield ahead. The section and construction of the tunnels and the arrangement of the working plant are shown on page 235.

Each tunnel has an outer wooden lining 24ft. 2in. exterior diameter, built up of pine segments sawed to shape. These segments are 9in. thick, 9¾in. wide, and 4ft. 8in. long, each ring being composed of sixteen segments and a short key. The rings are assembled in the tail of the shield as fast as it is pushed forward, each one being secured to the one behind by means of ½in. steel dowel pins. These pins are inserted in holes drilled in the segments before erection, and when the ring is assembled the pins are forced into the ring behind it by means of the hydraulic jacks.

A waterproofing membrane is applied to the inside of this wood lining. It consists of three layers of cotton fabric saturated with asphalt and mopped with hot asphalt. The first layer is placed with its mopped side against the lining and is nailed in place. The other two layers are then applied and are secured by successive moppings with hot asphalt. Inside the timber lining and waterproofing course is laid the 24in. concrete lining. It is not reinforced or armoured with steel bars, except that some reinforcement was used on the west side of the east tunnel in order to provide for the temporary stresses which result from the passage of the shield of the west tunnel, which latter was usually a few hundred feet behind the former. The horizontal displacement of the east tunnel due to the driving of the west tunnel beside it, with 5ft. clearance between them, was ⅜in.

Attached to the rear of the shield is a belt conveyor 110ft. long, carried on a steel frame on wheels which run on one of the two narrow-gauge working lines which are laid on the invert of the tunnel. This conveyor serves to carry the excavated material past the points where work is in progress on the lining, waterproofing, invert concrete, &c., and so avoid the interference due to the use of trucks, &c. The conveyor discharges the material into small tunnel trucks, which are hauled by storage battery locomotives. The upper view on page 230 shows one of these engines taking a train from the air-lock. The overhead platform is for shovelling the concrete into the forms.

Concrete is delivered in steel trucks of 1 cubic yard capacity, which are raised to overhead platforms from which the concrete is dumped and shovelled into the forms. There are two of these concrete lifts or hoists at each heading. One is just behind the shield, and takes trucks from the working line beside the belt conveyor to the platform from which the concrete is shovelled to the invert forms. The other is at the rear of the conveyor, and takes trucks from the same line on which the conveyor runs to a platform from which the concrete is shovelled into the arch form. The hoists and overhead platforms span the two working lines and the conveyor, and travel on two rails laid on the lower benches of the tunnel wall, as shown in the cross sections on page 235. Steel forms of the Blaw pattern, in 5ft. lengths, are used for the walls and arches. Three panel lengths, 15ft. long, are handled as a unit by means of a steel traveller which runs on the rails that carry the hoists and overhead platform. The forms are collapsible, so that a 15ft. length at the rear can be released and lowered on to the traveller, and moved ahead through the forms still in place, and then set up again in its new position forward of the completed arch. The lower view on page 230 shows the steel forms in place. At the right is the end of the frame carrying the belt conveyor, with the box containing the motor and gearing, and beyond it a spout for delivering the material into trucks on the left-hand line of rails. In the rear is the traveller for handling the forms.

The procedure in tunnelling is as follows: The material is first excavated for a distance of 20in. beyond the shield, and then the shield is advanced this distance. Two rings of the wooden lining are assembled in the tail of the shield, the waterproof coating of this being placed for the invert and the concrete invert laid. While this work is in progress on the invert, cement grout is pumped through holes in the wood lining to fill any voids in the surrounding soil. Then the waterproofing layer is laid on the sides and arch, and concrete is placed for the walls and arch. Finally, grouting is forced in at the top of the arch to fill any voids between the concrete and the waterproofing. The placing of the waterproofing and the concrete—in both the invert and arch—is done in lengths of 15ft.

The air-lock in each tunnel has three passages. The two lower ones—for the trucks—are 7½ft. diameter and 50ft. long. The upper one—used by the workmen—is 6ft. diameter and 30ft. long. The trucks are handled by lifts in the shaft, and the spoil is emptied from the tunnel trucks into larger narrow-gauge side-tip trucks, which are hauled by a tank locomotive and discharge their contents into barges lying in the channel.

The incline approaches and the top of the level tunnel under the channel were mainly in blue clay, with a hard mixture of sand, clay, gravel, and boulders in the lower part. There was also some soft shale and a ledge of hard shale which required blasting. The two shields were advanced 180ft. and 105ft. from the shaft before the flow of the clay made it necessary to put the headings under compressed air. The range of pressure required was from 12 lb. to 28 lb. per square inch, but was mainly 18 lb. to 22 lb. At one point it was necessary to increase the pressure to 28 lb. in order to drive through water-bearing sand. This water was fresh, and being under a higher head than that of the salt water in the channel above the tunnel, it was impossible to hold the air in the tunnel at sufficient pressure to keep back the water in the sand, as the depth of cover over the tunnel was insufficient to carry such pressure. The excessive loss of air by blowouts was overcome finally by depositing a clay blanket on the bed of the channel, and by timbering the entire face of the heading, removing the boards one at a time to make the excavation.

The work was carried on continuously with three eight-hour shifts per twenty-four hours. The maximum advance for one shield was 19ft. in twenty-four hours, 105ft. in seven days—15ft. per day; and 400ft. in thirty days—13½ft. per day. The average progress for a period of nine months was 9.3ft. per day for the east, and 10.8ft. per day for the west tunnel. This includes all shut-downs and delays for holidays, repairs, &c., and is for the completed tunnel, with concrete lining. If the tunnels had been entirely in blue clay the advance probably would have averaged 15ft. per day.

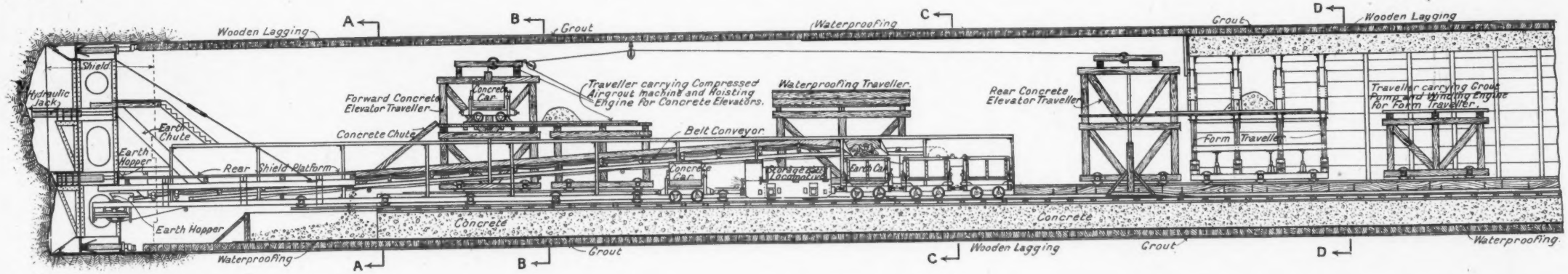
As to the time to be taken by men leaving the tunnel to decompress from the tunnel pressure to atmospheric pressure, experience indicated that for pressures up to 12 lb.—on the gauge in the tunnel—no time limit was necessary. For the higher pressures the limit should be one minute for each point of gauge pressure above 12 lb. It appears that occasionally a man passed by competent medical examination has an individual susceptibility to some form of compressed air disease, and no practicable rule will entirely eliminate trouble from this cause. The working force averaged 340 men in the day shift, 180 in the evening shift, and 180 men in the night shift.

The contractors were McGovern and Company, and all work was done under the direction of the chief engineer of the Boston Transit Commission.

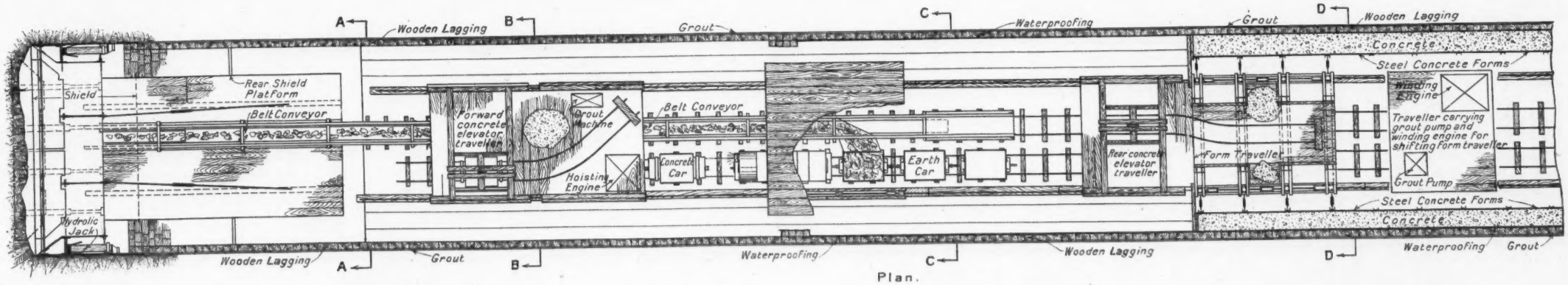
IF anyone had predicted a decade or less ago that the United States would once more be launched on the sea as a first-class sea Power by trying to win a race with Germany in building ships faster than the latter with her submarines can destroy them, there would, says the *Marine Journal* (New York), have been scoffers in plenty to stifle such a prediction. Nevertheless, that is the situation to-day. After three years of warfare in Europe, which is practically a tie between Great Britain and Germany and their respective allies, the fact is gradually becoming clear to everyone capable of thinking for himself that upon the United States shipyards now devolves the task of throwing the balance in favour of the British Allies. In other words, the journal continues, by a strange twist of fate it has become a question of whether we can build ships fast enough to overcome the destructive U-boat atrocities. To every true American, therefore, there is only one outcome of the war possible, as never yet have Americans been called upon for any service to their country but what it has been forthcoming.

CONSTRUCTING THE DORCHESTER TUNNEL AT BOSTON, MASS.

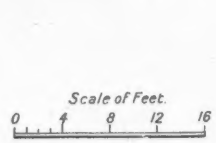
(For description see page 234)

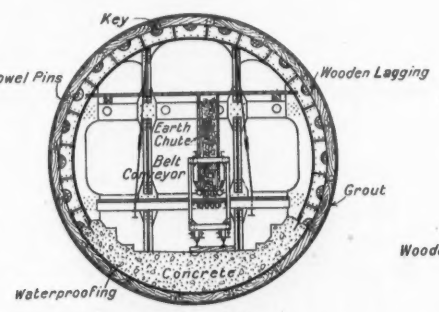


Longitudinal Section.

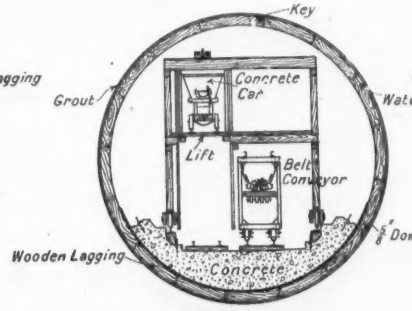


Plan.

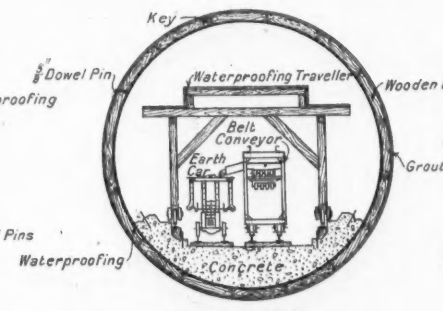




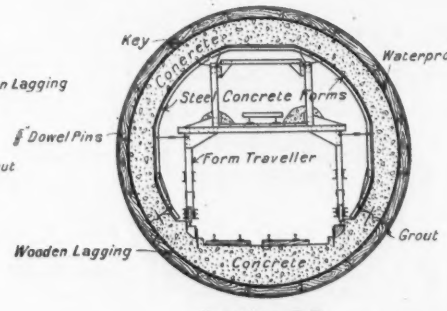
Section A.A.



Section B.B.
Showing Forward Concrete Elevator Traveller Hoist.



Section C.C.



Section D.D.
Showing Completed Tunnel with Steel Form and Form Traveller in Place.

SWAIN Sc.

"THE ENGINEER"

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Government and the Steel Sheet Trade.

THE matter of prices in the steel sheet trade, as they may be affected by any system of "control," which the Government may shortly adopt, continues to hold the field for interest in this part of the kingdom. It seems that not merely is the Government aiming at the regulation of values of black sheets used by the galvanisers and for merchant purposes, but also sheets of stout gauge or plates required for trench and similar purposes. As I have intimated in this letter for two or three weeks past the basis price which it is understood is in the mind of the Ministry of Munitions is voted by the trade generally to be definitely too low. It is not allowable in the present state of negotiations to divulge what the figure is, but sufficient is known to enable it to be stated that makers consider that the price limits contemplated would make the manufacture worthless to all except the big producers, who provide their own raw material in the shape of steel bars and billets. These, of course, are in the minority, while the rest have to go into the open market to get their bars for rolling down in the mills. As all the world knows, bars and billets are to-day at unheard-of quotations, and even at the extraordinary rates ruling supplies are exceedingly difficult to get, and are much below the needs of the market. Buyers, indeed, are declared by some selling circles on the Birmingham Exchange to be "ravenous" for supplies. Under these circumstances, for the Government to attempt arranging a price schedule, which at the outset the steel sheet makers unanimously vote as quite inadequate, would seem to be courting failure from the start and setting out upon a path which, to use only mild terms, must lead to disappointment. The present position of the trade is anomalous. Some makers continue to quote the old prices, and state that they have had no hint of control from the Ministry, while others have withdrawn quotations, regarding themselves apparently as under restraint. On the open market black sheets are quoted at the rate which has prevailed since October last, viz., £19 10s. for 24 W.G. Very little is being done in galvanised sheets, which remain at £28 10s. for export, and £29 10s. for home consumption. As illustrating the difficulty in getting sheet orders accepted, a report is going the round of the market that one large buyer, who recently inquired of twenty black sheet mills, received nineteen refusals to entertain the business "on any terms."

Bar Iron Trade.

Production in the bar iron trade falls so far short of demand, that strenuous efforts are being made in many directions to increase the output, but it is feared that they will not be very successful. Remarkable to state, at a time when the Government is calling urgently for increased outputs of iron and steel, plans which have been submitted for the erection of new works, and which could be carried out in a comparatively short time have, it is stated, this week been "turned down" by the authorities, who will not sanction the necessary employment of materials and labour, and who decline to authorise the additional expenditure which would be involved. As things are, the bar mills are running at the utmost pressure, and merchants are utterly unable to place specifications which they have in hand. The maxima of £15 10s., less 2½ per cent. for marked bars, and £13 15s. net at makers' works for unmarked bars, afford little indication of the real price position. A very large proportion of the bars which are now being sold command higher rates than these, and, indeed, as has been frequently of late mentioned in this letter, buyers will not "stand off" at hardly any figure if only they can secure delivery. Tube strip is quoted £15 10s., and hoops, £18 upwards. Makers generally have sufficient work on the books to keep them going fully until the end of the year, and then some definite advance in selling prices is anticipated. Nut and bolt iron is available at £14 5s. net, delivered to consumers' works.

Pig Iron Trade and Basic Output.

The supplies of pig iron, which are coming on to the market, are not equal to the demand. There is no acute shortage, but smelters are increasingly cautious about committing themselves. The change which is apprehended from the conversion of furnaces to the production of basic has made consumers more anxious to cover forward requirements, and tends, therefore, to cause an exaggerated disparity between supply and demand. The making of basic at Northamptonshire furnaces, which have previously helped to swell the output of forge and foundry qualities, is now actually in process, or is imminent. Some "off" iron, which is the trade description of the material produced during the transition stage, has a high manganese content, and is therefore held for good prices, being independent of the Control. Conversion of Derbyshire furnaces is also making further progress. Should any real shortage of forge and foundry sorts threaten, the authorities have the remedy in their own hands. They will presumably curtail the exports, which have latterly been on a fairly large scale. Values are right up to the full maxima. For South Staffordshire part-mine 100s. for forge and 102s. 6d. for foundry and all-mine, 115s. for forge and 120s. for foundry; while warm-air realises 145s. for forge and 155s. for foundry. Cold-blast pig is 182s. 6d. North Staffordshire, No. 4 forge, readily fetches 95s.; and foundry numbers, 97s. 6d. Some Northamptonshire makes are rather less in evidence, owing to pre-occupation of the furnaces with basic. No. 4 forge is 87s. 6d., while foundry numbers range from 89s. to 94s. Derbyshire houses are sold for months ahead, in some cases at 90s. for No. 4 forge, and 92s. 6d. to 96s. 6d. for foundry, according to grade. Basic iron stands at 97s. 6d. All these prices are f.o.t. at makers' works. Some houses which were ready enough to sell a month or two ago are seeking rather to avoid further commitments now.

Steel.

The shortage of steel remains unrelieved. All billets are now brought within the immediate scope of the Control. Producers can only make sales in accordance with the official allocation, and, of course, at the restricted price. This is involving some dislocation of old business connections, which both buyers and sellers would gladly avoid if they could. The whole of the wire rod produced at home is required for "A" certificate work. All that comes on to the market is a small quantity of American rod, for which fancy prices have to be paid. There is rather less pressure for steel strip, so far as new business is concerned. Manufacturers have considerable arrears on the books, and they are now making some impression on them.

Iron and Steel Scrap.

Disappointment has been felt so far as to the effect of the Government price regulations of iron and steel scrap. It was hoped that this would bring upon the market a large quantity which it was believed was being held back pending the issue of the Order. The increase in the supply, however, is far below expectations. There is a prevalent belief that a controlled price for plate shearings must either precede or accompany the control of sheets. The rolling mills have availed themselves pretty extensively of these shearings in lieu of sheet bars, and as much as £11 7s. 6d. and £11 10s. has been paid for them, against the £10 7s. 6d. which is the limit prescribed for sheet bars. In the present uncertainty the trade in plate shearings is naturally at a standstill.

Machine Tool Trade Activities.

The augmentation of productive capacity in many industrial branches is keeping all the machine tool shops in Birmingham fully employed in responding to the call for additional plant. Most of the large machine tool houses have orders on hand which will keep them going to the end of the year, and importation is also on a large scale. Firms are being urged to accelerate output by organising night shifts, and in other ways. The labour supply presents great difficulties, however, as in the majority of cases "dilution" has been carried almost as far as it seems practicable to carry it.

Ironfounders and Pipe Work.

Ironfounders in this district are busy. Derbyshire foundries, which, as reported recently, are short of work, are now in receipt of good inquiries, and the outlook is undergoing some improvement. Railway, water, and gas undertakings abroad are showing anxiety to secure supplies of pipes, more especially the smaller sizes. The Ministry is very chary, however, about granting authority either to produce or to ship. There are heavy stocks in hand, which producers would be relieved to see moving off. The possible contingency of cast iron pipes having to be used to a considerable extent in substitution for other kinds, of which the supply is not so plentiful, has, however, to be reckoned with, and the hesitation of the Ministry to release reserves is attributed to this consideration.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE iron and steel markets in this district do not show any particular change, and there is no improvement in the supply of finished material. There is, on the other hand, a distinct tendency to rise in all those materials which can be produced and sold without coming under official control. For steel bars, for instance, made from discarded shell steel, or from shearings from the plate mills, as much as £19 per ton can be obtained, and there seems no reason why the price should not go yet higher. The raw material from which such goods can be produced is, of course, in great demand; and while the controlled price of billets is £10 7s. 6d. people are anxiously searching for discarded steel at £16 10s. The unfortunate attempt to control prices, as distinguished from the far more legitimate and probably necessary controlling of profits, leads to innumerable irregularities. One cannot see any reason why the prices for these outside lots should not continue to rise, for it is absurd to think that a mild steel bar made from uncontrolled steel should sell at £19 to £20 per ton, while an American wire rod should fetch £29. Speaking of American material one is gla d to note that the process of cutting down prices has now begun in the United States, although it has not yet gone nearly far enough to raise any hopes of importations.

Hematite and Basic Iron.

The scarcity of hematite iron is rather more pronounced than before, and it seems probable that further reductions in the quantities which can be spared for export to Allied countries must take place. This will be unfortunate, but of course our own war needs must be first considered. The attempt to increase the output of basic iron continues, but whether it is wise to interfere with the Derbyshire furnaces may perhaps be questioned.

Foundry Iron.

The supply of foundry iron is, of course, further reduced by the recent order to the Derbyshire furnaces to make basic, but whether this will affect the Manchester consumer is not yet clear. It may, however, increase the demand for Cleveland foundry iron in the Lancashire district, and it is perhaps fortunate that Cleveland has rather more foundry iron to spare than was the case some few months ago. No doubt that district would be ordered to make more hematite and reduce the foundry iron output, but the difficulty is to increase the supply of hematite ores, and this problem has not yet been tackled successfully; or perhaps is incapable of a successful solution. Cleveland iron business is still hampered a good deal by the terms of the certificate, which warn the merchant off the trade; and the time has surely come for a fresh attack upon the authors of that remarkable document. In spite of this, however, it is probable that a good deal of Cleveland iron will go into the North of Lancashire, even if it does not come to Manchester. The cost of this iron delivered here is just 2s. 6d. per ton more than the cost of Derbyshire; but it would come in at 1s. 4d. per ton less than the price being paid for some of the Staffordshire foundry iron which still sells in Manchester, so that I cannot see any impossibility in the use of Cleveland foundry iron by Manchester ironfounders. The foundry trade does not seem yet to be getting more active in Lancashire, but it is difficult to judge, because even if large orders are taken for castings the makers have no inducement to cover at once their requirements in pig iron, because there is no likelihood of any change in the prices. Scotch foundry iron is quoted at the usual prices, *i.e.*, 128s. for Clyde No. 3 if bought direct from a maker or a maker's selling agent, and 129s. 6d. if bought through a merchant.

Scrap.

Trade in scrap generally is rather quiet, and with the exception of the business in steel turnings there is not much being done here. The demand for this class of material grows, and it is fairly clear that the maximum of 70s. is not equal to the real value from the consumer's point of view; that is, he would rather have steel turnings at 70s. (and perhaps at 80s.) than heavy melting scrap at 105s. The price ex yard for good heavy wrought scrap is £7, and if this price could also be legally paid for any scrap sold direct without passing through a yard, then there would be no object in waiting; but any such lots which may turn up can be charged only at £6 5s., and the difference to a consumer is certainly tempting. The foundry scrap market is quiet, but dealers are quite firm as regards the prices recently quoted, viz., 102s. 6d. delivered for ordinary castings, and up to 112s. 6d. for special qualities. There is no pressure to sell, and the quantity being made suggests that dealers will be able to remain content with small sales for a considerable time.

Metals.

There is no change in official prices. Lead is not offered here, but for small lots of spelter £62 per ton is quoted. Strong sheet copper, £160. Tin rather easy at £240 for English ingots.

Government Control and the Cotton Mills.

In both the spinning and manufacturing branches of the cotton industry the output is being restricted from Monday last for a period of twelve weeks by a Control Board appointed by the Government, in order to relieve the present scarcity of the raw material, and to equalise matters all round. Commencing with last Monday, all cotton spinners are required to run only 60 per cent. of their productive machinery, unless they receive licences to permit them to run more. In the latter cases penalties will be imposed. It is anticipated that the Government restrictions on output will be the means of displacing a considerable amount of labour, and to avoid the distress which would ensue from prolonged unemployment a system of rotation of workers has been devised. The operatives will thus work on alternate weeks, and when not employed will receive grants from a central fund, which will be replenished by the penalties imposed upon the owners of machinery worked in excess of the percentage stated above. The scale of payment for such cases has been fixed, and varies from 25s. per week downwards. These grants will, however, be subject to revision in accordance with the experience gained and the amount obtained from the levies. It is hoped that at the end of the twelve weeks the amount of raw material in stock will have increased to such an extent as to permit of normal conditions of work being resumed.

Manchester Tramway System.

Even before the outbreak of war the Manchester Corporation was alive to the necessity for taking drastic steps to relieve the congestion of the traffic in the streets, and the tramway manager, Mr. T. McElroy, paid visits to the Continent and America to study the passenger-carrying problems in the chief cities. Although, of course, there is not much likelihood of any new work being undertaken for some time the delay is only temporary. The Traffic Congestion Special Committee has issued a report on the subject, in which it insists upon the necessity for new trunk routes and additional tramway terminals. In regard to the old infirmary site, Piccadilly, the committee think that a widening and lengthening of Market-street would give all the room required for a terminal site. Six new tramway routes are recommended. The new terminals proposed by the Tramways Committee was as follows:—The old infirmary site, Albert-square, St. Peter's-square, Marsden-square, Cannon-street (Corporation-street), and a re-arrangement of the existing terminal in Stevenson-square. The Special Committee is of opinion that these terminals "are absolutely necessary, not only as a means of meeting the constantly growing demands of the tramway traffic, but also as a means of lessening the general traffic congestion in the central area of the city." It is recommended that negotiations be opened with Salford for co-ordinating the future working of the two tramway systems.

BARROW-IN-FURNESS, Thursday.

Hematites.

The activity in the hematite pig iron trade of North Lancashire is well maintained, and in Cumberland the set-back caused by labour troubles is gradually being got over, and the output will soon be up to the old level. Prices are steady at the maximum rates, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton, and special brands are quoted at 140s. per ton f.o.t. There is nothing being done in warrant iron. The old quotation of 115s. per ton net cash still stands, and the total held only represents 430 tons in the Furness storages.

Iron Ore.

The demand for hematite iron ore is very strong, and likely to remain so for a long time. The desire of raisers is to increase their output considerably above the present level, and with the recent settlements arrived at with the men, and the increases in wages and bonus granted, there is every hope that in the immediate future

more ore will be available. At present not much ore is allowed to go out of the district.

Steel.

For finished steel the demand is easy for the most part, but at times rails have been rolled on special account. The steel foundries are well employed. Prices are steady, with heavy rails at £10 17s. 6d. to £11, light rails £14 to £14 10s., heavy tram rails £14, billets £10 7s. 6d., ship plates £11 10s., and boiler plates £12 10s. per ton.

Fuel.

The demand for coal is full, and prices are steady at the old rate of 25s. to 27s. 6d. per ton delivered for steam sorts, and house coal is at 27s. 6d. to 37s. 6d. per ton delivered. Coke is in urgent request, and East Coast qualities are at 33s. to 35s. 6d. per ton delivered. Lancashire cokes are at 31s. per ton delivered.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

ALTHOUGH business for the time being is quiet, the Cleveland pig iron trade maintains a firm tone, and there seem to be prospects of an expansion in the home demand during the coming autumn. Already there is a better inquiry from the Scottish foundries, and some substantial sales of forge iron for delivery over the next three months are reported, whilst the expectation of a busier period for the North of England foundries also will probably be reflected ere long in an improved demand for Cleveland iron. Local makers are very anxious to dispose of forge iron, which constitutes the great bulk of their existing stocks, and it is reported that they are prepared to entertain business at a figure representing some reduction on the maximum price. The shortage of trucks appears to be not so pronounced, and deliveries under existing contracts are proceeding more regularly. On the export side business remains somewhat featureless. The demand from abroad, however, continues very keen, and the trade is only limited by the licences and tonnage facilities. France, of course, still takes the bulk of the iron, but the needs of Italy are not overlooked, and a few licences have been issued for the export of Cleveland iron to Japan. Notwithstanding the ban upon exports to neutrals, inquiries from the latter still come in, but any relaxation of the embargo is more than ever unlikely, having regard to the needs both of the home and the Allied Governments. Prices generally are unchanged, home business in No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge being regulated by the official maximum of 92s. 6d., with a premium of 4s. for No. 1, whilst the export quotations are as follows:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; No. 4 forge, 100s. 6d. per ton.

Hematite Pig Iron.

The stringency in the East Coast hematite pig iron trade is absolutely unrelieved and tends, in fact, to become more intense. Deliveries are reported to be going forward satisfactorily to home consumers, who cannot expect, in existing conditions, to get more than will keep them going from day to day. There is, of course, only one way out of the present difficulty, and that is to enlarge production. It is understood that the preparations for the extended manufacture of basic iron from native ores are being actively pushed forward, but they involve numerous questions concerning plant and labour, and any early development on a large scale can hardly be looked for. The export demand is extremely heavy, and is practically impossible to satisfy, for the surplus available for shipment is severely limited. Nevertheless, great efforts are being made, consistently with the satisfaction of the minimum home requirements, to meet fairly all the urgent military needs of the Allies. There still remains a large volume of applications awaiting consideration, and this tends to hold up new inquiries. There is as yet no official announcement regarding the question of export prices, although traders have agreed on an export price to the Allies of 141s. in place of the old quotations of 137s. 6d. to France and 142s. 6d. to Italy. Sanction is also awaited to the proposal that the excess ore freights charged by neutrals above the parity shall be added to the price. Very great importance attaches to the question as to whether this charge shall be retrospective, particularly as the uncertainty has continued for fully six months. Merchants are in a peculiarly difficult position, for while it is easy enough for makers to debit them with the excess, it is another question altogether to obtain the money from foreign clients whose contracts have probably long been completed. The home maximum price stands at 122s. 6d. for East Coast mixed numbers.

Iron-making Materials.

In the foreign ore trade it is reported that supplies are coming forward a little more freely. There have been some relatively small transactions at official rates this week, but the arrears under old contracts are such that for the most part consumers are under no necessity to enter the market for new business, being more concerned with securing deliveries under existing contracts. Coke is in good supply, but prices are firm, good medium furnace kinds being quoted 30s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trades presents few new features at the moment. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £13 10s.; packing iron, tapered, £15 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, ½in. and upwards, £13 10s.; 5/16in., £13 15s.; ¼in., £14; 3/16in., £16; ⅛in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12, all less 2½ per cent., except ship plates, angles and joists, packing iron and iron bars.

The Coal Trade.

There is an absolute lack of movement in coals, and dullness and want of feature mark the entire market. The problem of small coal in Northumberland is increasing in gravity. One colliery is laying down a briquetting plant to convert its smalls into briquettes, and this seems to be a very practical plan which might be adopted by other collieries. It is suggested that a remedy might be found in the intervention of the Coal Controller to secure that unscreened coal should be sold instead of screened. There must be many consumers at home and abroad who could take unscreened coal at a lower price if they had an opportunity of doing so, and certainly at home the Controller might notify consumers that it would be an advantage to the Northumberland pits if unscreened coal could be substituted for large wherever possible. The local committees set up by the Coal Controller to deal with arrears of contracts entered into prior to May 1st, are now sitting and adjudicating on merchants' claims. There would appear to be a determination to refuse deliveries against these arrears, unless good cause is shown, and cases of hardship proved. The industrial demand for fuel continues quite active, and there is a great deal of curiosity now being displayed as to the effect of the new coal transport scheme for home supplies, which comes into operation this month. There is, moreover, a somewhat uneasy feeling that house coal supplies during the forthcoming winter may be considerably curtailed, and domestic consumers are watching the position somewhat anxiously. There are no special features in the Durham coal trade; export business also being very slow in this section. The principal quotations are as follows:—Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade, 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 28s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SHEFFIELD.

(From our own Correspondent.)

The Cutlery Trade and Machinery.

WHETHER it really has sufficient force behind it to sweep over the entire industry, I do not know, but there is a remarkable wave of machinery reform passing over a portion of the cutlery trade just now. Groups of employers and also employees are evincing undoubted concern about the matter. Table-blade grinders long ago introduced machinery, simply because they found themselves faced with the alternatives of doing so, or retiring from the field, and the necessity brought about by the war was responsible for the installation of a fair number of machines for making razors throughout. Certain spring-knife makers also have put down machinery, recognising the need of jig and other repetition plant. But this movement has so far been of a desultory nature. For instance, only a certain proportion of the table-blade makers possess grinding machines; the others send their blanks to be ground at the works of more enterprising concerns. Now cutlery manufacturers in greater numbers than ever before are candidly acknowledging that the one hope for the future to their trade lies in having a certain number of patterns of their various productions, and greatly multiplying the output of each. That position, of course, admits at once the need of machinery installation wherever possible, and even where, up to the present, it has been considered impossible or impracticable. At the same time, the industry is awakening to the wisdom of employing competent engineers to look after the machinery, and see that the best is obtained from it. Hitherto, firms installing machines of one kind and another, seem to have too often overlooked that point altogether, the result being that their spirit of enterprise was damped by disappointing experiences. Then, many of the men themselves are asking for opportunities to be instructed at evening classes in the handling of modern cutlery machinery and machine tools. I have personally received several letters from inquirers of this kind, and I am not without hope that something to meet their desires may be done before long. These requests from the men are the more remarkable because, up to quite recently, the spirit of labour was entirely antagonistic to machinery installation. Gradually, however, the men have been brought to see that it will mean for them the earning of better wages, with considerably less labour, and that, after all, is what they want. As in the glass trade of the United States, in particular, the great forward movement was largely due to the influence and help of engineering, so it seems will be the case with the cutlery industry.

Leaving Certificates Again.

An interesting point was raised at the Munitions Tribunal here the other day. Two rolling mill hands applied for leaving certificates and compensation. The case for the men was that on the previous Saturday, Monday, and Tuesday, they went to their working places at the proper time, but were unable to do anything, because on the two latter days the set was short of a couple of men. They were offered no other work, they alleged, so left the place, with the result that the present application was made. The firm's representative said the men had been engaged on gun springs, and, to his own knowledge, on the dates mentioned, they had not asked for work. On the Monday they were offered ordinary rolling to do, but refused it on the ground that there was not sufficient to start on. The firm's representative added, in explanation, that the men would not work unless there was a certainty of a full night. His experience was that, if, say, 50 cwt. of cogging was required, and there was only 35 cwt. of material available, men would not make a start. One of the men, however, in reply to the chairman, declared that even if the material had been short, they would have commenced work had there been a full set. In the end, the chairman said it seemed to the Court that the applicants were clearly entitled to their leaving certificates, and to a week's compensation. They were at their place at the proper time, and had been given no work through no fault of their own. There was no official present who could find them work, so that after waiting half-an-hour they went home. It was no part of their duty to run after the officials or to go looking for work. It was the duty of the officials to provide it if the men were in their places in time. One man, therefore, whose average wage was 48s., would receive that amount as compensation, and the other, whose average earnings was 34s., would have that amount awarded to him, and both men must have leaving certificates. Then a curious thing happened. The firm's representative, addressing the Court, observed that both men had resumed work on the Wednesday and Thursday nights, whereupon the Chairman reversed the order as to leaving certificates; but, after a considerable discussion on the question of compensation, granted each man three days' pay.

Sheffield and Aeroplane Work.

An exhibition of British and German flying machines in Sheffield, this week, gave Lord Montagu of Beaulieu an opportunity of paying a tribute to the part Sheffield is taking, and has almost from the commencement of the war, in the making of aeroplanes. This is not a subject upon which one can dwell with safety in the ordinary way, but Lord Montagu gave some idea of what is being done, when he said that no place during the war had thrown itself heart and soul into the production of munitions more than Sheffield had. There was, he said, an unfortunate strike a little time ago; but, on the whole, both masters and men had done their best to increase the output of munitions, and of all kinds of things necessary for aeronautics. He hoped that the spirit would not only continue, but that the good-will between masters and men and the conviction that they were working for the nation, in one of the most essential trades, if not the most essential, would prevail and increase. Sheffield was, he added, doing a lot of work in connection with aeroplanes. The women were doing their share, as well as the men, and he appealed to all to remember that this was not a time to bicker about details. It was a time to remember that the Allied cause was one which must now be fought for harder than ever. After all, the life of an aircraft was a short one. The wastage of parts and machines went on at a greater rate than the ordinary man in the street could possibly imagine. If they were to have aircraft, and their pilots were to do well with them, they must produce great numbers—much greater than most people had any conception of at the present time. If everything else that Lord Montagu said is forgotten, except one sentence, viz., "This is not the time to bicker about details," his lordship's mission to Sheffield will have have been a great success if that sentence is taken well to heart. Most troubles that have arisen here have been very little more than bickerings about some minor detail. The big things are borne without a murmur.

Round the Works.

The activity in munitions production appears to be still on the increase, and the demand for tools required elsewhere for a similar purpose, either directly or indirectly, is very heavy. Makers of files, especially of the larger kind, cannot possibly keep pace with orders, though the shops are working continuously. Exactly the same thing applies to hack saws and twist drills, though in these cases fair quantities are coming into this country from Canada and the States. The persistent call for engineers' small tools, and for tool steel, both carbon and high speed, is extraordinary. Some of the new electric furnaces have now been got nicely into operation on the last-named quality as well as on ordinary steels, and are proving valuable auxiliaries of the crucible furnaces. The embargo on stainless steel is probably in consequence of the Government's heavy requirements of this material in aircraft construction, the restriction having been placed actually upon the use of chrome ore, one of the essentials of "stainless." This means that very little more of the now popular cutlery will be seen on the market for the present—perhaps for the duration of the war—though afterwards it is fully expected that a great boom will be experienced in stainless steel for cutlery and very many other purposes. At the Thorncliffe works of the well-known Sheffield iron and coal firm of Newton, Chambers and Co., the other day a 70-ton anvil block for a 5-ton steam drop-stamp was successfully cast. The casting, which was a record for the works, required two 50-ton ladles, and the block is about 10ft. by 9ft. by 6ft., the approximate weight of metal used being 75 tons. Special cranes have had to be arranged for for loading the anvil for transport. Government tenders are out for 5000 chisels, and a few hundred hammers and scissors, and a colliery company—the New Monkton—is inviting tenders for the construction of a reservoir of nearly a million gallons capacity. Crushing machinery for the gold mines is in full demand, and a considerable amount of railway material is required over sea, but the home market for tramway work is held severely in check by war conditions, the latest contracts of this kind including points and crossings for the Glasgow Corporation. New overseas business of a general kind is undoubtedly suffering through the restrictive hand of the Government, but there is evidence of a relaxation being probable in the immediate future. Should it prove to be what is hoped, manufacturers here will warmly welcome the change of policy, as they have long been in the position of having to turn down more business than they could accept, or, at least, if they accepted much the hope of executing it was very slender. The Tribunal returns showed that the number of hours lost during August was 5173, against 9555½ in the previous month, the average per case being 75 against 83.08 in July. The announcement made at the

annual meeting of Charron, Limited, that the company had acquired a controlling interest in the Sheffield firm of W. S. Laycock, Limited, caused no special surprise here. It was known that, since the death of Mr. W. S. Laycock, more than one large concern had been looking in the direction of this well-known engineering firm, with a view to fusion or acquisition.

Yorkshire Colliery Managers.

The Frickley Colliery of the Carlton Main Company was visited on Tuesday by the Yorkshire branch of the National Association of Colliery Managers. This colliery, which has been working for about a dozen years, is laid out on very up-to-date lines, the weight of Barnsley coal raised per week from a depth of close upon 2000ft. being between 15,000 and 16,000 tons. The surface equipment much interested the visitors. The cages each hold twelve tubs in the two decks, the tubs being banked simultaneously by hydraulic decking apparatus. Coal is raised at the rate of a wind a minute, and the force of gravitation is largely utilised in the very expeditious dispatch of the tubs from the pit shaft to the screens and back to the shaft. Skilful use is also made of gravitation at the pit bottom, with a result which the visitors found even more impressive than operations at the surface. Storage room below for hundreds of full corves enables a concentration of output sufficient to provide for continuous winding. Generally winding is carried on by means of the downcast shaft only, but at Frickley there are facilities whereby, on emergency, coal can be diverted to the upcast shaft in a few minutes, and dealt with there without any interference with the working of the pit. The whole of the surface, except the winding engines, is worked by a 4000-kilowatt plant, which also drives the main haulage underground.

Iron, Steel, and Coal.

The shortage caused in the output of forge and foundry iron through the conversion of so many furnaces to basic iron production continues to be felt rather keenly. It is not perhaps so much that the demand for the former is particularly strong as that makers are looking ahead and wondering if the business which they are now having to drop will ever be recovered. In that, however, they will have to take their chance with very many others, for in the case of some of the steel firms connections of years' standing have had to be abandoned, and may never be regained. But opportunities will present themselves for almost everyone in new fields. Hematite deliveries are fairly good, the consumption here being chiefly of the special qualities. There is apparently a big demand for bar iron, though the actual truth is that a good deal of competition exists for the restricted supplies available, the output being limited chiefly, perhaps, through the shortage of puddlers. There is still little new to report regarding the steel position. The scrap market is strong, and would be very active if holders were more responsive; but in regard to scrap iron sellers do not yet seem altogether clear or satisfied with the new regulations. There is a strong inquiry for scrap steel, shell discards being largely absorbed by the cutlery people, who have to use it now in place of open-hearth steel. In the coal market the coming into operation of the Controller's scheme on Monday made practically no difference to steam fuels, as exemption has been granted in regard to all coal used for manufacturing purposes in the Sheffield district; but for house coals, of course, substitution arrangements have had to be made where fuel was coming in from areas now prohibited. Otherwise the market is almost unchanged. Best South Yorkshire steam hards are quoted 17s. 6d. to 18s.; Derbyshire, 16s. 9d. to 17s.; seconds and steam cobbles, 16s. 6d. to 16s. 9d.; washed smalls, 12s. 9d. to 13s. 3d.; best hard slacks, 12s. 3d. to 12s. 6d.; seconds, 11s. 9d. to 12s. 3d.; soft nutty, 12s. to 12s. 3d.; peas, 10s. to 10s. 6d.; and small slacks, 6s. to 6s. 6d. In house sorts branch is quoted 21s. to 21s. 6d., and best Silkstone, 18s. to 18s. 6d. per ton at pits.

SCOTLAND.

(From our own Correspondent.)

Pig Iron.

The demand for pig iron is unabated. Supplies, however, are becoming scarcer, and some brands are difficult to secure, especially for private consumption. Hematite is almost entirely absorbed at the local steel works, while forge and foundry iron are also, to a large extent, exclusively used on national work. Prices are firm and unchanged.

Quotations.

Monkland and Carnbroe are quoted, f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder, and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, and Dalmellington, at Ayr, Nos. 1, 126s. 6d.; Nos. 3, 121s. 6d.; Shotts and Carron, at Leith, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

As time goes on it is becoming more apparent that still less material is available for ordinary distribution, and stocks everywhere are running low. Consequently, where prices are not under control, very high figures are quoted, and in many cases willingly paid when deliveries are guaranteed. At the steel works nothing is now being manufactured apart from war materials, with the exception of occasional orders deemed to be of national importance. Steel sheets are particularly scarce, and outputs are entirely absorbed by naval and military requirements. Ordinary black sheets are quoted in the vicinity of £18 5s. per ton, net, for export. Galvanised material is practically off the market. In the malleable iron trade, too, the ordinary turnover has dwindled away to vanishing point, both for home consumption and for overseas customers. "Crown" iron bars have touched the unprecedented level of £16 per ton, f.o.b. Glasgow. The engineering shops and the shipyards are still subject to a ceaseless pressure, and the output has reached a very high level.

Coal.

Conditions in the Scotch coal trade generally continue dull and uninteresting. The restrictions in force produce a considerable reduction in the volume of business, and the position is not likely to improve until these become less stringent. In the West of Scotland the collieries are comparatively well employed. Industrial demands are maintained, and are being supplemented by a growing household turnover, and steady sales on Admiralty account. In Fifeshire and the Lothians, however, the situation is totally the reverse, and idle time is very prevalent. Local requirements are quickly satisfied, and business from other sources is meagre. The aggregate shipments from Scottish ports during the past week amounted to 158,982 tons, compared with 165,756 in the preceding week, and 180,293 tons in the corresponding week of last year. Ell coals are quoted f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s.; first-class screened navigations, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s.; best steams, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE arrangements of the Government authorities for the control and supply of coals for home consumption would appear to be now pretty well complete. Orders have been framed affecting the colliery owners, the wholesale coal factors and merchants and the retailers, and it will be interesting to see how everything works out. It must, however, be some time before everything gets into proper shape and working order. By the time these notes appear, a deputation from the South Wales and Monmouthshire Wholesale Coal Factors' Association will have had an interview with the Coal Controller, with regard to the Order which affects them, viz., the Wholesale Coal Prices Order, 1917.

Wages Award.

The South Wales Miners' Federation recently applied to the Monmouthshire and South Wales Coke-ovens and By-products Works Association for an advance of wages and alteration in the working conditions, on behalf of the men employed at the Risca Coke Ovens, and the matter was referred to the Committee on Production. The application was as follows:—(1) That the present rate was not to be altered. (2) Colliery percentages to be added to all standard rates. (3) That time and a-half for week-ends be paid from 2 p.m. on Saturdays instead of the present practice of paying from 6 a.m. on Sundays. (4) The afternoon and night shifts to be paid the bonus turn upon the same conditions as the bonus turn paid to colliery workmen. (5) That the present holidays be increased from five days per annum to the usual colliery holidays of twelve days per annum, and (6) any workmen called upon to work on any of the holidays to be paid time and a-half. The parties were heard on August 29th, and the Committee on Production has now given its findings, which provide that the following increases be made in the existing base rates per shift:—Ovens: Chargers, 6s. to 6s. 5d.; winchmen, 6s. 3d. to 6s. 4d.; gas regulators, 6s. 6d. to 6s. 7d.; quenchers, 6s. to 6s. 5d.; and ram enginemen, 6s. 6d. to 6s. 7d. By-products: Exhaustermen, 6s. to 6s. 7d.; and benzolmen, 6s. 6d. to 6s. 7d. Washery: Washers, 5s. 6d. to 5s. 9d.; tippers, 5s. 6d. to 6s.; labourers, 5s. 6d. to 6s. The award also provided:—That the existing war bonus of 25 per cent. be increased to 35 per cent.; week-end work between 2 p.m. Saturday and 6 a.m. Monday be paid for at the rate of time and a-half; that the claim that afternoon and night shifts should be paid the bonus turn upon the same conditions as the bonus turn paid to colliery workmen has not been established; and that time worked on statutory holidays, including Good Fridays, be paid for at time and a-half, but that the claim to extend colliery holidays to the coke plant cannot be entertained at the present time. The award applies as from the beginning of the first full pay following the 7th inst.

Finishing Time.

At the various iron and steel works at Cardiff, Dowlais, Ebbw Vale, Cyfarthfa, &c., there is no fixed time for finishing work on Saturdays, and the men have, through the South Wales and Monmouthshire Iron and Steel Workers' Association, approached the employers in order that knocking-off time should be definitely fixed at one o'clock on Saturdays.

Current Business.

There has been extremely little fresh business on the market during the past week. Colliery salesmen have had a particularly difficult and anxious time in the matter of keeping pits working. Practically all were enabled to make a start on Monday, but since then the shortage of empty wagons, through heavy stocks, has compelled owners to resort to temporary stoppages. Practically all classes have suffered, though bituminous coals have moved off well as the result of the heavy inland demand. Colliery salesmen have been engaged very much upon completing arrangements with purchasers under the Coal Transport Re-organisation Scheme, which came into operation on Monday. In one or two cases collieries which have had certain business allocated to them under this scheme have been informed by the purchasers that they do not want their particular coal on the score of its unsuitability for their requirements. The majority of colliery salesmen are stipulating for cash with order, which is rather resented by the purchasing firms. The chief reason for coalowners making this condition is that they are afraid that in case the purchasers do not find that the coal is exactly to their liking, they will make claims for deductions in the price. Small coals continue to give coalowners considerable trouble, owing to the excessive quantities which are on hand, and are hampering their working. Values rule according to the schedule. Coke is quite a strong market at 47s. 6d., and patent fuel rules steady at 30s. to 32s. 6d. Pitwood supplies are more limited, and values are maintained at 60s. to 61s.

Schedule Prices.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 22s. 6d.; unwashed duff, 14s. to 18s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Eastern Valleys, 29s.; seconds Eastern Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d. Patent fuel, 30s. to 32s. 6d. Coke, 47s. 6d.; pitwood, ex ship, 60s. to 61s.

Newport.

The position regarding the Monmouthshire section of the coal trade displays no notable improvement. Owners find great difficulty in keeping stocks within reasonable limits. Inferior qualities are suffering most. The inquiry generally is on very restricted lines. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s. to 32s. 6d.; pitwood, ex ship, 60s. to 61s. 6d.

Swansea.

The anthracite coal market continues to maintain a fairly good tone. Shipments are fairly active, and beans and peas are particularly scarce, but the demand for rubbly culm and duff is rather meagre, and consequently stocks have accumulated. Steam coals are irregular, more especially throughs and smalls. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 8s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, through, 23s. 6d.; smalls, 17s. Bituminous coal: No. 3 Rhondda large, 27s.; smalls, 24s. Patent fuel, 30s.

Industrial Unrest.

The Chamber of Commerce adjourned meeting was held at Cardiff on Wednesday for the consideration of the report of the Commissioners for Wales upon industrial unrest. A resolution was adopted to the effect that whilst agreeing with the recommendations of the Commissioners which aimed at more friendly relations between employers and employees, and the fairest possible division of the proceeds of industries in which they are jointly engaged, the Chamber was of opinion that a number of other recommendations, if adopted, would be extremely injurious to the future industrial well-being of the country. It was decided to appoint a committee to draft a report showing wherein they disagreed with the Commissioners' report, and making counter-proposals.

Tin-plates.

The tin-plate market continues very firm. Owing to the shortage of steel bars, mills have been working short time. Merchants contend that the 2 per cent. margin of profit, which includes brokerage, is not sufficient, while makers are of opinion that the fixed prices, which are on the 30s. basis f.o.t., are not sufficiently high. Quotations:—I.C. 20 × 14 × 112 sheets, 108 lb., 30s. Block tin, £242 per ton cash; £241 15s. per ton three months; copper, £120 per ton cash; £119 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

FORTHCOMING ENGAGEMENTS.

WEDNESDAY, SEPTEMBER 19TH.

INSTITUTE OF METALS.—Rooms of The Chemical Society, Burlington House, Piccadilly, W. 1. Annual autumn meeting. For programme see page 215. 4 p.m. and 8 p.m.

THURSDAY, SEPTEMBER 27TH.

ASSOCIATION OF RAILWAY COMPANIES' SIGNAL SUPERINTENDENTS AND SIGNAL ENGINEERS.—Railway Clearing House, London. Fifty-fifth Conference.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Caxton Hall, Westminster. Paper: "Standard Locomotive for British Railways," by Mr. J. F. Gairns. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ON account of the lack of ocean transportation facilities at the present time, the Dominion Bridge Company, Limited, of Montreal, Canada, has decided to close temporarily its office in London. Until it is reopened the interests of the company will be looked after by the Export Association of Canada, Limited, 62, Charing Cross, S.W., to whom inquiries should be addressed.

THE Crittall Manufacturing Company, Limited, of Braintree, informs us that it is now able to undertake complete chemical analysis of all metals and alloys, and of various raw materials, including coal and fuel, refractories, &c.; heat treatment and pyrometer tests; microscopical examinations of all classes of metal, and the determination of the physical properties of iron, steel, and all alloys.

WE are informed that Bromell Patents Company, Limited, manufacturers of "Simplex" specialities for power plants, have just completed the building of the first section of their new works in Glasgow.

FERRO-CONCRETE POWER-HOUSE AT GREENOCK.

A NEW power-house and coal storage of ferro-concrete construction has been built for the Glebe Sugar Refinery, Greenock, and possesses novel features. The power-house, coal storage, and cantilever roof constitute a single structure, monolithic throughout. The floor of the power-house is 24ft. above ground level, and supports two reciprocating engines, seated upon a plain concrete foundation 9in. thick, laid directly upon the ferro-concrete floor slab of 6in. thickness. On each engine seat the load is 25 tons, and the floor is so designed that no vibration may be perceptible when the engines are in full working order. This engine-house floor is a continuous slab, carried by longitudinal beams over two rows of columns, bringing the surface of the engine-house floor 24ft. above ground level. There are two intermediate longitudinal beams, 5in. wide by 18in. deep, and four transverse beams, each 14in. wide by 28in. deep. The cantilever roof is over the boilers, and projects 17ft. beyond the supports.

The whole structure—engine-house, coal storage, and cantilever roof—is supported by nine ferro-concrete columns in three rows. The columns in one row support the power-house; another row supports one side of the power-house and one side of the coal bunkers; and those in the third row support the other side of the coal bunkers and the cantilever roof over the boiler-house. Six of these columns are 1ft. 9in. square, and the other three measure 2½ft. by 1ft. 9in.

The power-house measures 40ft. by 22ft. 5in., and is 21ft. 4in. high inside—the roof lantern rising 6ft. above ceiling level. Three of the outer walls are 4in. thick, and the party wall next the bunkers is 6in. thick at the foot, tapering to 4in. at the top. Counterforts in the form of pilasters are built, with the two side walls of the power-house having bracketed extensions to carry a 10-ton travelling crane, installed for the purpose of lifting parts of the engines for examination and repair. The wall between the bunkers and power-house is designed to act as a partition between these two portions of the general structure, and the necessity of placing the central row of columns about midway between the bunker wall and the exterior of the discharge outlet for coal has led to details in providing for the transference of the load from the power-house beams to the supporting columns. The longitudinal main beam connecting these columns acts as a stiffener for the hopper bottoms of the bunkers, in addition to supporting the power-house floor, and the four transverse beams of the latter pass through the longitudinal beam at the right hand, so as to form cantilevers for the support of the corresponding wall of the power-house.

The roof over the boilers is cantilever planned, and projects 17ft. beyond the supports. It consists of four cantilevers, 12in. wide, and of varying depth, increasing as the supports are approached, two series of longitudinal beams, measuring 4in. by 9in. respectively, and a continuous roof slab 3in. thick. A gangway over the front end of the boilers is suspended from the roof. The receiving hopper for coal is constructed in the ground; the coal passes into it from trucks on the railway siding, and is elevated thence to the top of the storage bunkers.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W. 1.

ORDERS

For the week by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Second Lieut. E. A. Ullman.

Next for Duty.—Second Lieut. C. E. Campbell.

Extract from Gazette.—County of London Volunteer Engineers. Alfred Hugh Gibbon to be temp. Lieut. and Medical Officer, 10th August, 1917.

Monday, September 17th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill No. 3 Company, Left Half Company. Signalling Class 6.30. Recruits' Drill, 6.30.

Tuesday, September 18th.—Physical Drill and Bayonet Fighting.

Wednesday, September 19th.—Drill and Elementary Bridge Construction for No. 3 Company, Left Half Company.

Thursday, September 20th.—Drill and Elementary Bridge Construction for No. 2 Company, Left Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, September 21st.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Sunday, September 23rd.—Commandant's Parade for Technical Instruction at Esher Parade at Waterloo Station 8.45 a.m., opposite No. 10 Platform. Uniform, haversacks, water bottles to be worn. Mid-day rations to be carried. Compulsory for "A" and "B" men.

Band.—All buglers and drummers who have not attested are required to attend on Monday or Thursday next at 6 p.m.

Uniform.—"A" and "B" men are warned to attend headquarters on Tuesday, September 18th, to be measured by the regimental tailor for the service uniform.

Musketry.—All N.C.O.'s and men who have signed the "A" and "B" agreements, are required to attend during this month to re-classify, in order to enable the Corps to obtain the capitation grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be had at headquarters, and every enrolled man must obtain one without delay; at the same time all old red armlets (now obsolete) must be returned.

Note.—Unless otherwise indicated all drills will take place at headquarters.

By order,
MACLEOD YEARSLEY,
Captain and Adjutant.

September 15th, 1917.

IRON AND STEEL INSTITUTE.

AUTUMN MEETING, SEPTEMBER 20th-21st.

Alterations in Programme.—In addition to the list of papers announced in the programme of the autumn meeting, issued on August 24th, Committee No. 3, for the manufacture of Open-Hearth Steel, will present reports on "Metallurgical and Mechanical Practice in Open-Hearth Steel Works," in which British and foreign practice is compared. It has been arranged to hold a special session at 3 p.m. on Thursday, September 20th, for the purpose of discussing these reports.

The paper No. 6 in the original programme, by Mr. E. F. Law, on "Effect of Mass on Heat Treatment," cannot be ready in time for the meeting, and is deferred to a future occasion.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

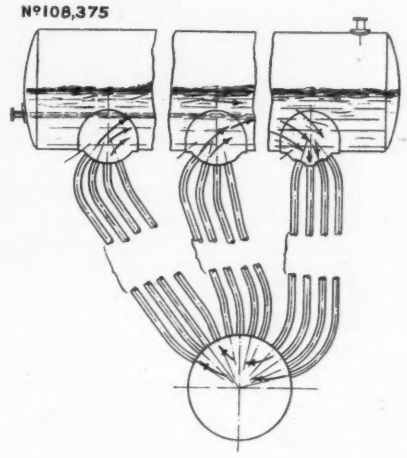
The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

108,375 (12,114 of 1916). August 26th, 1916.—WATER-TUBE BOILER, *Edward Charles Robert Marks, 57 and 58, Lincoln's Inn-fields, London, W.C.* (a communication from abroad from the firm Deutsche Babcock und-Wilcox-Dampfkessel-Werke, A. G. Oberhausen, Rheinland, Germany).

This invention is for a water-tube boiler having longitudinal upper and transversal lower drums connected together by groups of water tubes. The groups of water tubes enter the longitudinal upper drum by the provision of water-tube walls or

Nº108,375



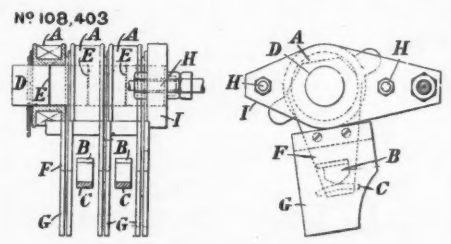
tube plates in such a manner that the water rising in the water tubes is directed mainly in the direction of the longitudinal axis of the upper drum. With this object the tube walls or tube plates receiving the water tubes are cylindrical or polygonal or consist of stepped planes or have grooves or pockets and elevations for inserting the water tubes, as shown in the accompanying drawing.—*August 9th*, 1917.

DYNAMOS AND MOTORS.

108,403 (15,007 of 1916). October 21st, 1916.—MOTOR CONTROLLERS, George Ellison and another, Victoria Works, Warstone-lane, Birmingham.

This is a magnetic blow-out device. Coils A approximately equal in width to the pitch of the fixed and movable contacts B and C are wound and coaxially mounted, so that the like poles lie together. The core of the coils is formed from a number of sections D of iron, each section extending approximately halfway into an adjacent pair of coils, leaving an air gap E between each pair of sections or core parts which is filled with a disc or plate of insulating material. Between each pair of coils and in magnetic connection with the core is a plate-like pole piece F

Nº 108,403



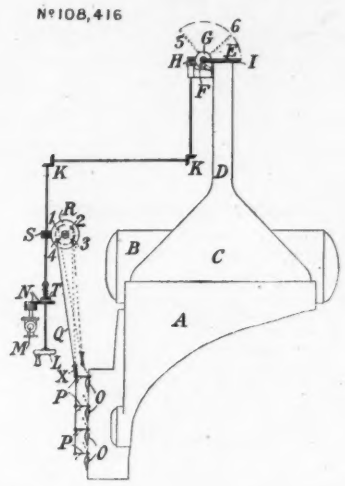
constructed to extend laterally into the space between a pair of contacts like the shields usually employed Each pole piece has arranged on one or both sides a covering of non-conductive material forming a shield G. By the arrangement above described, a strong magnetic field is produced in a direction parallel to the axis of the coils or the spindle carrying the movable contacts, and by such field the arcs set up when separating the contacts are extinguished. If by chance any arc should make an electrical connection with an adjacent pole piece, a short-circuit is prevented by the sectional construction of the coil core. The system of coils is clamped by side rods H between end plates I and is mounted in the controller frame.—*August 9th*, 1917.

SHIPS AND BOATS.

108,416 (16,869 of 1916).—SUBMARINE VESSELS, Harold Edgar Yarrow, Scotstoun, Glasgow.

This invention is for a means for closing the top of the funnel of a steam-propelled submarine vessel when the latter is submerged, together with mechanism for cutting-off the oil supply to the burners and shutting the air doors to the furnaces. In the illustration, A is a boiler, B the steam drum, C the uptake, D the funnel, E a valve hinged at F for closing the top of the funnel when the vessel is submerged. G is a worm wheel rotated by a worm H adapted to open or close the valve about its hinge F. The seating I of the valve is secured to the top of the funnel, and packing of leather, or other suitable material, serves to make the valve water-tight when the vessel is submerged. The worm H is rotated by spindles and bevel gearing K. Assuming the valve E is in the open position, the rotation of a hand wheel L closes the oil fuel supply to the burners at a valve M by means of gearing N. When this valve is completely closed a spring clutch T slips. While the hand wheel L is closing the valve M a worm wheel R, engaging with a worm S on the spindle operated by the hand wheel, moves from a position 1 to 2, but during this motion a connecting-rod Q, pivoted to a radius of the wheel R and hinged to levers P operating air doors O of the furnaces, is only moved vertically by the small amount represented by the versed sine of the arc between positions 1 and 2. A further movement of the hand wheel L brings the wheel R into the position 3, in which the air doors O are closed. While the worm wheel R is moved from position 1 to

Nº108,416



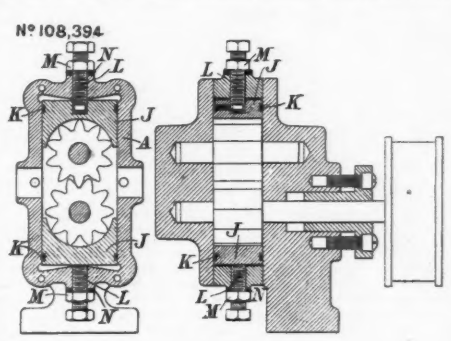
position 3, the funnel valve E is moved from position 5 to position 6. A further rotation of the hand wheel will move the wheel R from position 3 to position 4 and will close valve E. The small vertical movement of the connecting-rod G between positions 3 and 4 is taken up by a spring X. The oil fuel supply valve is first closed, then the air doors, and finally the funnel valve.—*August 9th*, 1917.

PUMPING AND BLOWING MACHINERY.

108,394 (13,817 of 1916). September 28th, 1916.—ROTARY PUMPS, George Henry Boot, 18, Richmond-road, Bearwood, Smethwick.

Rotary pumps constructed in accordance with this invention are provided with blocks J fitting between the walls of the pump chamber A and forming adjustable plugs or closure pieces for the chamber. These blocks are made to a sliding fit between the walls of the chamber, and each has a concave surface corresponding with the diameter of the toothed wheel or impeller which is to rotate in contact with it. The blocks can be

Nº 108,394



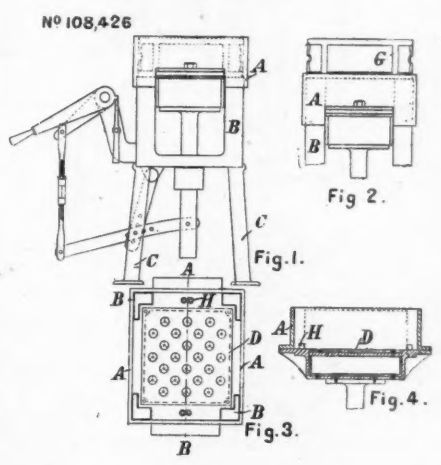
fitted with leather or other packing K. Adjustment of each block with relation to its wheel is effected in one manner by means of a screw L projecting through the pump chamber, having its inner end abutting upon or engaging with the block. On its exterior portion, such a screw may have a nut M with a leather or other washer N to form a water-tight joint. Adjustment of the blocks can also be effected by means of a spring or springs arranged at the back of each block and adapted to maintain its concave surface in contact with the wheel or impeller for which it is employed.—*August 9th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

108,426 (18,550 of 1916). December 28th, 1916.—MOULDING MACHINES, Johnson Turner, 28, Plumpers-road, Sheffield.

This is an improved form of moulding machine, in which a

Nº 108,426



rectangular box A slides up and down four upright standards B on the pedestal C. A detachable perforated plate D is fastened, as shown, to the wood pattern to be used. The pattern and plate D, so secured together, are inserted in the box A, and the plate

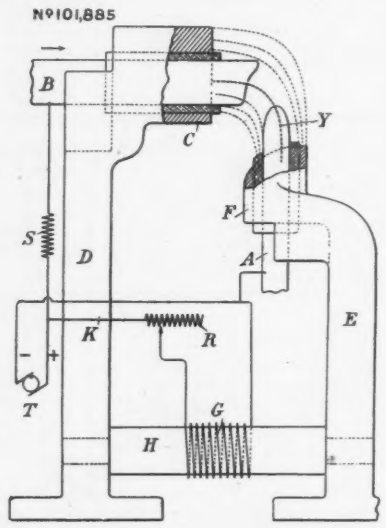
is attached to the bottom of A by screws. The next proceeding in the case of small moulds is to insert in the box an ordinary frame to receive the sand mould, but in the case of large moulds a rectangular metallic skeleton frame G, which has sides but no top or bottom, and is made an easy sliding fit for the box A, is used. The moulding sand is then rammed up around the pattern and between the various members of the skeleton frame G, until the whole is pressed into a compact mass. To remove the mould from the box the latter is lowered, and since the skeleton frame rests on top of the standards B of the machine framing, it and the sand mould are left supported on the standards, the wood pattern being, of course, withdrawn from the sand by reason of the fact that the plate D to which it is secured is attached to the bottom of the box A, and so moves with it. The mould can then be removed. To ensure the accurate registering or alignment of the moulds, tubular metal sockets H, in conjunction with guide pins, are employed. These sockets may either have twin eyes connected by a web—as shown in Fig. 3—or be of plain tubular form with a single eye.—*August 9th*, 1917.

LIGHTING AND HEATING.

101,885 (14,930 of 1916). October 20th, 1916.—ARC LAMPS, Daniel Frost Comstock, 9, Harcourt-street, Boston, Mass., U.S.A.

One object of this invention is to enable an arc carrying a heavy current to be used as the source of illumination in a projection apparatus requiring intense light. Other objects are to provide an improved method of control and devices for the regulation and control of the position with respect to the electrodes of an arc light, so as to maintain the brightest portions of the light-emitting area in the same position with regard to the condensing lenses of optical apparatus, such as searchlights or projecting lanterns. A and B are the carbons, the latter having an automatic feed. The pole piece C is offset, so as to bring its face within the parallels of the parts D, E. The part E has also a pole piece F oppositely and similarly offset, and the carbon A is carried at an angle to the carbon B for lengthwise adjustment. The pole piece C is preferably so designed as to leave a greater mass and surface above than below the carbon B, and the surface of pole piece F is preferably sloped or curved to

Nº101,885

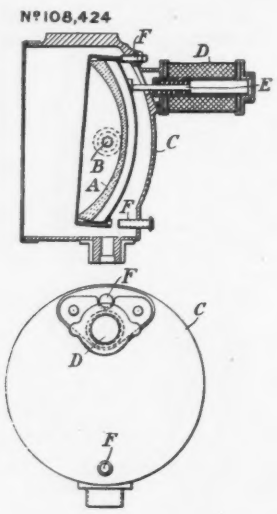


lie roughly parallel to the bisector of the angle between the electrodes. An exciting coil G is wound on any suitable part of frame D, H, E, for instance, on the connecting piece H. When coil G is energised, a magnetic field exists in the dielectric between the pole pieces C and F in which equal lines of force may be conceived of as defining an envelope or capsule having striæ, substantially central upon an arcuate axis Y at the desired direction and position for the central axis of the arc proper, the magnetic direction everywhere lying substantially parallel to the arc and completely surrounding the area of possible flow of current or charged particles in passage between the carbons. As shown, one arrangement of circuits comprises a coil G connected in a shunt circuit K, containing if desired a variable resistance R, the circuit K being in parallel with the arc—and if desired, a series resistance S—with respect to the current leads from the source of energy T.—*August 9th*, 1917.

108,424 (18,503 of 1916). December 27th, 1916.—ELECTRIC SIGNALLING LAMP, Harry Lucas, and another, of Joseph Lucas, Limited, Great King-street, Birmingham.

This invention is for an electric signalling lamp in which a focus filament bulb is mounted in conjunction with a mirror, the latter being caused to oscillate by means of an electro-

Nº108,424



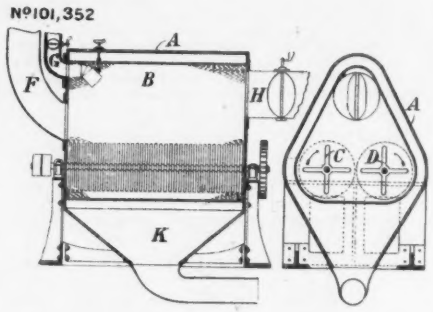
magnet. In carrying the invention into effect, a lens or mirror A is pivoted at the ends of a diameter B, so that it can be tilted for the purpose of occulting the signalling beam. Behind the mirror frame or the case C is an electro-magnet D which is connected to an electric circuit containing a battery and signalling key. Movement is transmitted to the mirror by the magnet in one direction through a plunger E. A spring serves to return the mirror to its proper position after each deflection. Suitable stops F are provided to limit the movements of the mirror. By the employment of means as described, the mirror can be actuated from a distance, and in consequence, the lamp can be placed in one position and the operator in another.—*August 9th*, 1917.

TEXTILE MACHINERY.

101,352 (12,309 of 1916). August 30th, 1916.—OPENING AND CLEANING MACHINE FOR TEXTILE FIBRES. Friedrich Emil Max Hilbert, 10, Kreuslerstrasse, Hamburg, and another.

This is a machine for opening, cleaning and freeing from dust and other impurities cotton and similar textile material without injuring the fibres. The apparatus comprises an outer and an inner perforated casing A, B, in which revolve in opposite directions two shafts C, D fitted with arms. The fibrous

Nº101,352



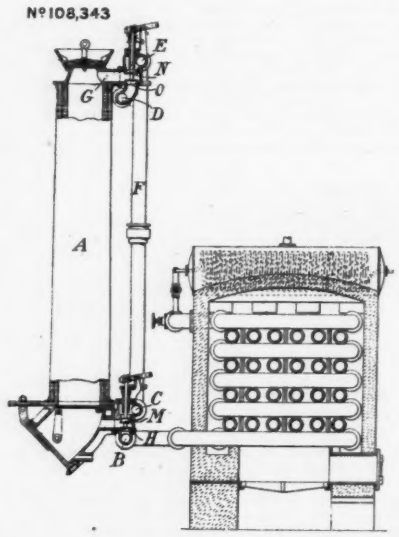
material enters through the pipe F and air through the pipe G, in which the air is controlled by a throttle valve. H is a pipe through which the air and cleaned material are exhausted. K is the pipe to conduct away the dust and dirt. The inventors claim that the fibres are thrown against one another in a closed space by the aid of two rotary agitating devices with such force as to open the fibres and free them from dust and impurities without injury.—*August 9th*, 1917.

MISCELLANEOUS.

108,343 (10,726 of 1916). July 28th, 1916.—APPARATUS FOR THE DISTILLATION OF COAL, Frederick Lamplough, Trafalgar House, Waterloo-place, London, S.W., and others.

This invention provides a process for the low temperature distillation of coal by which superheated steam at low pressure is used to effect the distillation. The vertical retorts A are built with two parallel mains B and C along the bottom, and another pair D, E along the top. B is for superheated steam, and C is connected by the downtake F with the by-pass main E; D is the gas main. Normally superheated steam is admitted from the main B through the valve H into the bottom of each retort, and the distillate escapes through the duct G under control of the valve O from each retort into the gas main D. Normally the valves M and N are all closed, and if the retorts are all equally packed all will be approximately equally heated. This, however, rarely is the case, and in result some retorts

Nº108,343



receive more steam than others, and in some the action tends to proceed relatively too rapidly and in others relatively too slowly. When, therefore, it is seen that the action in one retort is proceeding too slowly, one or more of the valves N are opened slightly and the corresponding valves O slightly closed. This diverts into the by-pass delivery E some of the hot gas which otherwise would have been delivered into the gas main D. At the same time the valve M on the retort where matters are proceeding too slowly is opened and a hot gas from the other retorts passes from the main E by way of the down-take F and the main C into this last retort to promote the distillation there. Thus by careful attention to the battery, economy in heat is secured and the different retorts are uniformly worked.—*July 30th*, 1917.

108,353 (10,851 of 1916). August 1st, 1916.—PORTABLE FODDER PRESS, Ernest Alexander West, 4, Dryburgh-road, Putney, London, S.W.

The drawings show a press mounted according to this invention. Fig. 1 is a front elevation when the press is in a vertical position, and Fig. 2 is a similar view when the press is in a horizontal position. A is the head of the press and B its base upon which is a trunnion C supported by a bearing D secured to the carriage E. On the other side of the press is a similar trunnion supported by a bearing upon the carriage. A bracket F is secured to the carriage by bolts L and to the press by bolts M when it is in a vertical position; another bracket G is secured to the press by bolts N and to the carriage by bolts O when the press is in a vertical position. When it is desired to turn the press into a horizontal position, the bolts M and O are withdrawn, thus allowing the press to be turned upon its trunnions C until the head A of the press comes into contact with a cross beam H by which it is supported. The carriage is provided with wheels J, and when the press is in use cross

Nº108,353

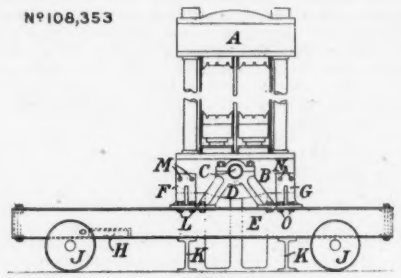


Fig. 1

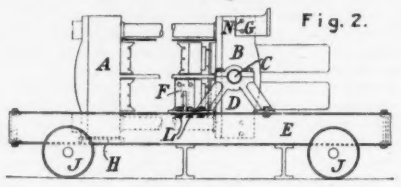


Fig. 2.

beams K of any desired length are inserted beneath the carriage, as shown in Fig. 1. The beams K form a firm foundation for the press when in use.—*August 1st*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of three of the patents given below £26 *and on each of the remainder* £18 *have been paid in renewal fees.*

No. 27,764/10.—Making buttons, &c. Coloured moulded buttons and other articles are produced from casein, resins, or other materials by pressing, in a moulding machine, the material in a powdered state to the form of the required articles. Rutgerswerke-Atk.-Ges., Berlin. Dated August 24th, 1910.

No. 27,890/10.—Pianos, organs, &c. In a pianoforte, organ, or other key-board musical instrument, the leverage of a key varies when it is operated. Clutsam, F., Berlin. Dated October 5th, 1910.

No. 28,064/10.—Breathing apparatus. In breathing apparatus of the regenerative type, check valves in the exhaling and inhaling pipes are opened and closed automatically by the mounting and dismounting of the absorbent case, whereby the case may be changed while the miner remains in the poisonous atmosphere. Dragerwerk, H., and B. Drager, Germany. Dated December 2nd, 1909.

No. 28,178/10.—Emulsions; paints. Asphalt, coal tar pitch, petroleum pitch, paraffin, Montan wax, Japan wax, and mixtures thereof, are emulsified by fusing with saponifiable substances, such as resin, naphthenic acid, or fatty acids, and then treating at or above 100 deg. Cent., with alkali or ammonia, or with an alkali or ammonia salt of resin, naphthenic acid, or a fatty acid, preferably containing an excess of alkali or ammonia. The emulsions are suitable for coating damp walls. Wallbaum, R., Berlin.

No. 28,655/10.—Bearings. A cage for spacing ball bearings consists of a sheet metal ring lying to one side of the row of balls, and formed with struck-up lugs, which pass between the balls and are bent over to form loops which serve to retain the cage in position. Depressions to receive the balls are formed in the ring. Schweinfurter Präcisions-Kugel-Lager-Werke, Fichtel and Sachs, Germany. Dated August 6th, 1910.

No. 28,836/10.—Road-covering materials. A composition for covering roads, paving, &c., which may be applied cold, consists of about equal parts of cement, and filling-material such as sand, stones, &c., and wood tar. The materials are mixed and spread on the surface to be covered, or slabs may be made. In cases where the mixture of cement and wood tar sets too rapidly, the mixture of cement and filling material may be moistened with water and allowed to stand before adding the tar. Wiedemann, H., Germany.

No. 29,046/10.—Cellulose filaments, &c. Cellulose filaments, &c., containing a small quantity of copper, and produced in the ordinary way by precipitation in a bath of soda lye and sugar, are on leaving the bath first wound on iron rollers, washed thereon exclusively with warm water, and then removed by opposite rotation of the drum. Vereinigte Glanzstoff-Fabriken Atk.-Ges., Germany. Dated October 20th, 1910.

No. 29,077/10.—Road trains. Trains of single-axle vehicles are coupled in pairs by a coupling which does not permit movement about a horizontal transverse axis, the front truck of each pair in the direction of travel being driven. The remaining couplings allow movement in any direction. Reik, H., Vienna. Dated December 15th, 1909.

No. 29,125/10.—Actuating valves and electric switches. Relates to apparatus for controlling gas valves or electric light switches at predetermined times. Scheidemann, B., Berlin.

No. 29,460/10.—Vehicle wheels; disc wheels. Wheels for artillery vehicles comprise two discs, the edges so formed being bent at right angles to the plane of the wheel and connected by plates which are partly radially disposed and partly concentric with the nave, and are riveted thereto. The rim has two inwardly projecting ribs by which it is secured to the disc. Rheinische Metallwaaren and Maschinenfabrik, Germany. Dated December 24th, 1909.

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VOL. CXXIV.—No. 3221] LONDON: FRIDAY EVENING, SEPTEMBER 21, 1917. [PRICE {WITH SUPPLEMENT} EIGHTPENCE BY INLAND POST TENPENCE

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PRINCIPAL: W. H. HADOW, M.A., D. Mus., J.P.

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JOHN FREDERICK WAKE, DARLINGTON. 715 G

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One 45ft. × 5ft. 6in. Egg End BOILER TANK £110
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800 H.P. PUMPING ENGINE, by Hick-Hargreaves, Corliss valves, pumps for 2½ tons pressure per square inch.
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Special 300ft. series TANGYE PUMP, cylinder 14in., pump 10in., stroke 24in., suction 10in. £80
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Four PULSOMETER PUMPS, low prices.
Six CENTRIFUGAL PUMPS, 4in. to 8in. outlets, belt and engine driven. 716 G
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FOR SALE.

Engines. — Vertical Pair, each 150 H.P., 12in. and 19½in. cylinders, 18in. stroke, 200 revs., and one Vertical, 10in. cylinder, 14in. stroke; all by Marshall.
BOILERS.—Galloway, 26ft. by 7ft.; 18ft. by 6ft., and 15ft. by 6ft.
PUMPS.—Three Westinghouse Vertical and one Worthington Vertical.
MOTORS.—One D.C., 240 v., 3000 revs., 3 H.P.; one A.C., 460 v., 25 periods, 3-phase, 2½ H.P.; also one 15 H.P. Control Panel.
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For Sale:—
45 RIVETED STEEL GIRDERS,
2ft. high, 9in. on flange, 25ft. 8in. long, two ribs in middle, ¼in. plate top and bottom, ⅜ plate centre three plates at bottom.
15 RIVETED STEEL GIRDERS,
22in. high, 9in. on flange, 25ft. 10in. long.
2 TANKS,
8 × 8 × 4.
2 CYLINDERS,
Steel, fitted with tubes, 12ft. 6in. × 3ft. 6in.
18 ROOF SPANS,
in new condition, 18in. high in centre, 3ft. 1in. ends, 27ft. long, made of two 6 × 3 channels, and braced by 3 × 2 steel angles.
All price £12 per ton, delivered free to works or f.o.r. London. Apply—
C. A. ROBINSON AND CO., Anchor Iron Wharf, East Greenwich, London, S.E. 607 G

THE EVOLUTION OF THE CHAIN-TRACK TRACTOR.

No. VII.*

THOUGH not quite in correct order of date, we may conveniently continue our reference to Mr. Diplock's work, by drawing attention to others of his patents.

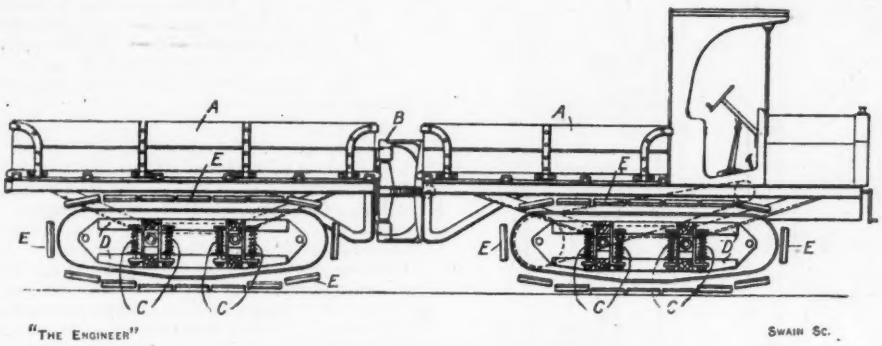


Fig. 68—DIPLOCK CHAIN-TRACK TRACTOR, 1912

Let us take, first of all, No. 14,491 of 1912, and No. 16,402 of 1913. Speaking broadly, the central idea in both these patents is to reduce friction, and hence the effort required either to propel or haul the vehicle.

play of the foot, which is required when the vehicle is turning, is obtained by the movement of the rod within the carrier, whilst the tilting is provided for in its connection to the lower end of the rod. In the mechanism springs play a leading part, as we shall show, and we understand that the improvement in efficiency brought about by their introduction was very considerable. The feet carrier may be arranged with wheels to run on rails as in the 1910 patent, but preferably, as shown in the drawings to which we are about to refer, it has pivoted to it two or more slippers, which bear on roller chains of special form, which themselves run on the rails.

In Fig. 68 is given a diagrammatic elevation of a motor vehicle constructed in accordance with the invention. In it the body A is divided into two halves pivoted at B, the vehicle being steered by what is described as "the well-known way" of turning one half relatively to the other about the pivot. Each half of the body is suspended by springs C on two wooden frames work D, to each side of each of which is fixed a frame, the two pairs of frames being supported on two endless chains of feet E.

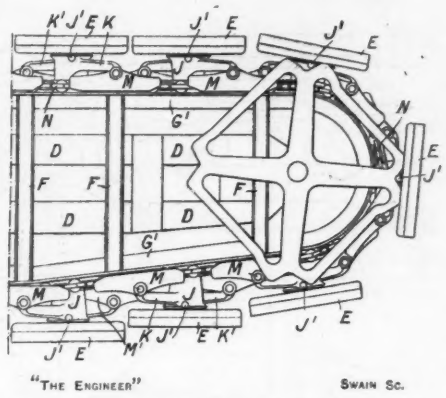


Fig. 69—SPROCKET WHEEL AND CHAIN OF FEET—DIPLOCK, 1912

As shown in Figs. 69 and 70, each frame consists of channel bars F, to which the rails G and G^1 and H and H^1—see Fig. 70—are fixed. The rails G and G^1 are cross shaped, while the rails H and H^1 are angle bars.

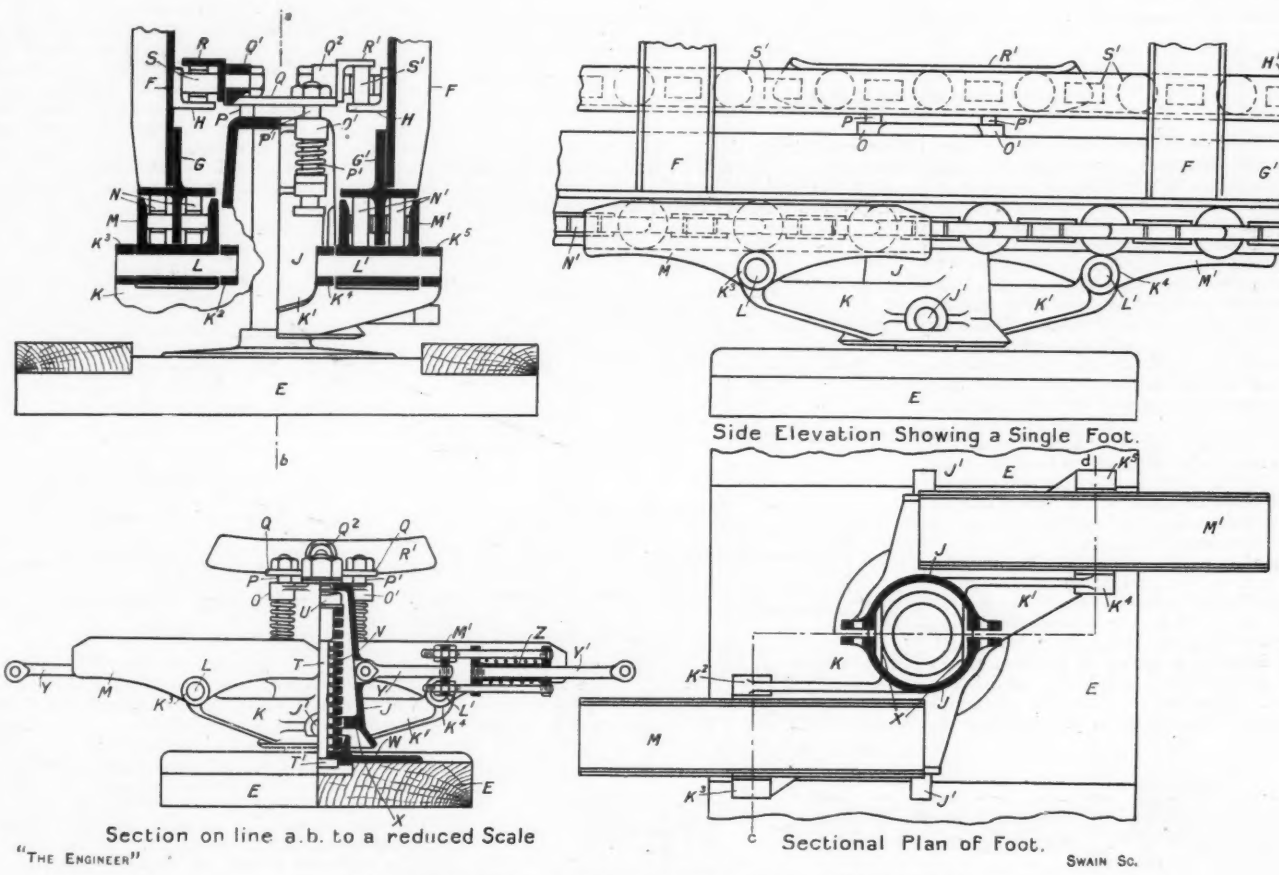
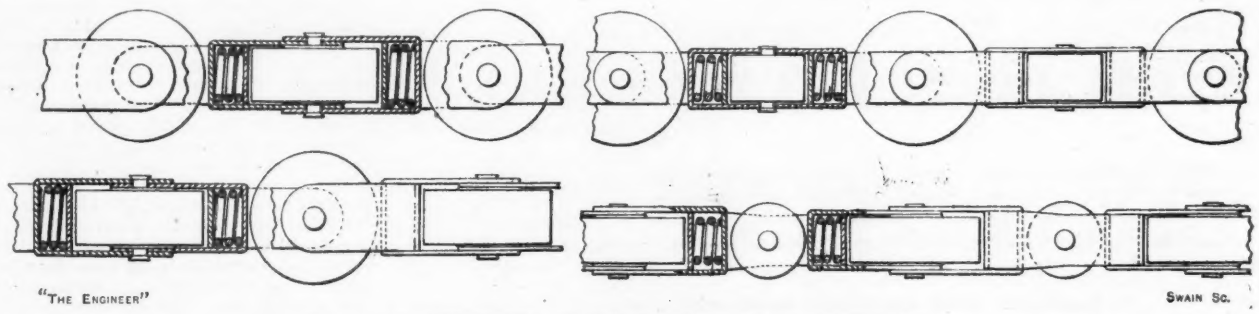


Fig. 70—ARRANGEMENT OF FEET AND FEET CARRIERS—DIPLOCK VEHICLE, 1912

As we have already said, Mr. Diplock is most averse to hinging the feet of the endless chains rigidly together, and in the invention of 1912 he goes further than he had previously gone in reducing the rigidity of the feet connections. In it each foot is carried by the lower end of a rod, the upper end of which is suspended from the apex of a carrier. The sideway

Each foot carrier consists of a bell J made in halves and having two arms K and K^1 projecting from its lower part, one on each side. Each arm has at its ends two bearings K^2 and K^3, K^4 and K^5 respectively, and working in these bearings are the pins L and L^1, which form the pivots for the slippers M and M^1. Interposed between the rails G, G^1 and the slippers M and M^1 respectively are double roller spring



Figs. 71 and 72—ARRANGEMENT OF ROLLER CHAINS—DIPLOCK VEHICLE, 1912

* No. VI. appeared September 14th.

chains N and N¹, which are of special type, and the construction of which we shall describe later.

Projecting from the upper part of the bell J are bosses O and O¹ which act as guides for the pins P and P¹ which project downwards from the underside of the plate Q. These pins are embraced by springs, the effect of which, acting in conjunction with adjustable lock nuts in the lower parts of the pins, is to tend to draw the plate Q downwards, the extent of its travel being limited by the bosses O and O¹. The plate Q has fixed to it bearings Q¹ and Q², which receive pins that are fastened to the slippers R and R¹. Interposed between these slippers and the rails H and H¹ are the double roller chains S and S¹ respectively. The construction of these will also be described later. It will be realised from what has been said, that the effect of the springs which embrace the pins P and P¹ is to draw the slippers M M¹ and R R¹ towards one another, and to hold them and the roller chains in contact. Since the slipper M¹ is in advance of the slipper M, as will be seen in the drawings, it is necessary—in order to hold the bells vertical and the feet horizontal as they are approaching the ground—to bend the ends of the rails G and G¹ differently, but this is a point of detail into which, for our present purpose, we need not go.

The method of suspending the foot E from the bell J is best seen in the left bottom illustration in Fig. 70. In this T is a rod passing through a hole in the apex of the bell. At its top it is provided with a nut and washer with, preferably, though it is not shown in the drawing, a spring in between them. The underside of the washer is spherical, and it fits into a spherical recess at the top of the bell. A second nut U on the rod T has in its top a spherical recess to receive the spherical underside of another washer, the upper face of which bears against the underside of the apex of the bell. V is a spring surrounding the lower part of the rod T and the lower part of the nut U, which is reduced in size for the purpose. The upper end of the spring abuts against the flange thus formed on the nut U. The lower end of the rod T has a head T¹, this head being received in a recess formed in the upper face of the foot E and being kept in place by a cover plate W which is fixed to the foot.

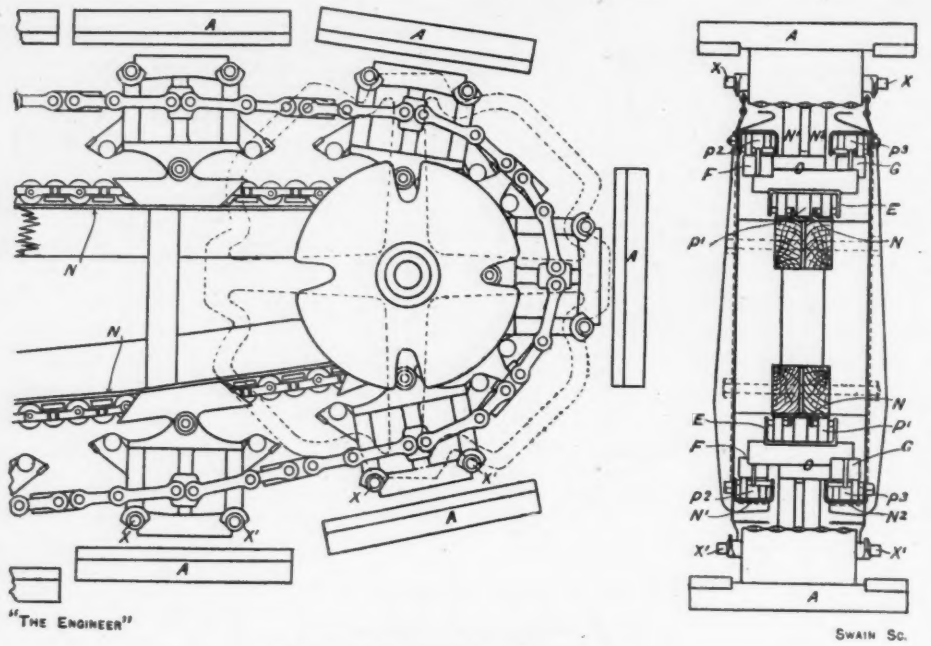


Fig. 73—THE DIPLOCK CHAIN-TRACK, 1913

The recess is larger than the head, so that the foot can tilt relatively to the rod T; but since the head bears against the underside of the cover W, whilst the spring V bears on the top of the cover, the foot is, normally, held at right angles to the rod. The rod and spring are prevented from swinging forwards or backwards in the bell, except to a very limited extent, by the guides X, but they are free to move to and fro transversely.

The same drawing—that in the left bottom corner of Fig. 70—shows the way in which the bells J are connected together. A link Y is secured to the front of one bell, and a link Y is pivoted to the rear of the adjacent bell. A plate is connected by rods to the link Y and another plate is fixed to the end of the link Y¹. Between these two plates is a spring tending to force the plates apart, and hence to bring the bells nearer together. A sleeve Z embraces the link Y¹, and its ends abut against the two plates just mentioned. By this arrangement the bells are prevented from going further apart than is permitted by this sleeve, which acts as a distance piece, though they may be pulled nearer together by the action of the springs. The bell carriers should be at their maximum distance apart when they are passing round the sprocket wheels.

In Fig. 69 is seen one of the sprocket wheels. The sprockets engage with pins J¹ formed on the arms K and K¹, so that as the wheel revolves the chain of feet also revolves. In a tractor vehicle the sprocket wheel is, of course, actuated by the engine. The wheels and the rails G and G¹ are so formed that the slippers M and M¹ are, as they pass round the ends of the vehicle, separated from the chains N and N¹, and the arrangement is such that the slippers are simultaneously separated from the two chains of each bell, in spite of the fact that one slipper is in advance of the other. The pressure on the roller chains S and S¹ is at this point relieved, because the rails H and H¹ are so formed that the chains are only in contact with the slippers R and R¹ when the feet carriers are engaged with the sprocket wheels. The object of thus separating the slippers M and M¹ from the chains, and the chains S and S¹ from the rails, is to allow the springs of the chains to act and bring any rollers which may have been displaced back to their normal positions at equal distances apart. This point will be made more clear when we explain the construction of the chains, as we shall almost immediately do. First, however, it should be pointed out that the surface of the slipper, which comes in contact with the chain, is formed with a concavity in the centre of its length, so as to ensure that the slipper is always in contact with at least two rollers, one on each side of the pivot, even when it is travelling in a curve, as when going over the sprocket wheel.

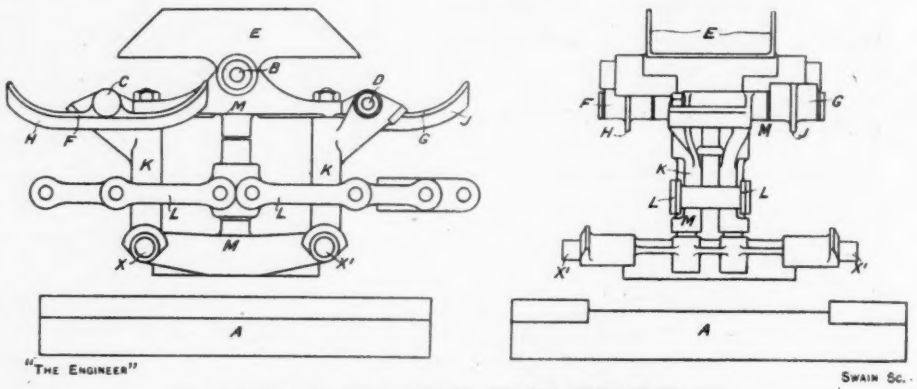


Fig. 74—FOOT AND FOOT CARRIER, DIPLOCK CHAIN-TRACK, 1913

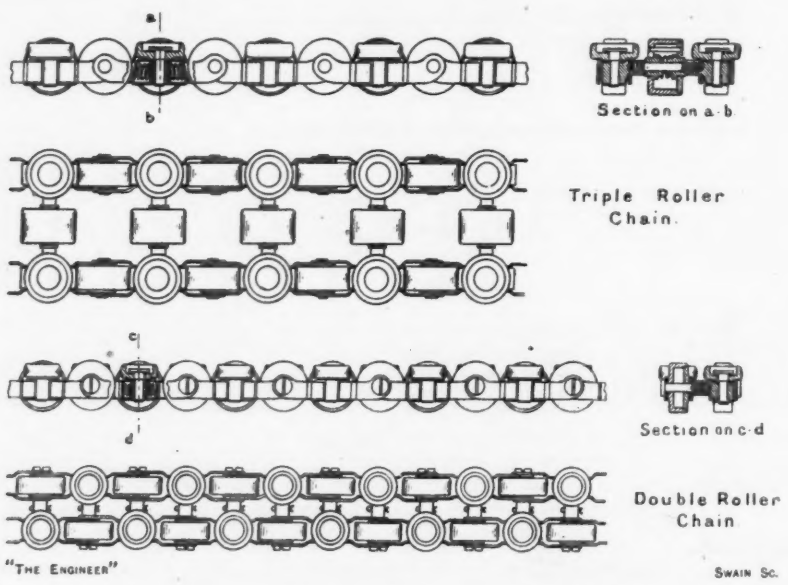


Fig. 75—DIPLOCK TRIPLE AND DOUBLE ROLLER CHAINS, 1913

The principle on which both pairs of roller chains N and N¹ and S and S¹ are constructed is the same, though the details vary slightly. Thus the chains N and N¹ are as shown in Fig. 71, and the chains S and S¹ as in Fig. 72. Each chain, as will be seen, consists of a series of rollers arranged alternately at right angles to one another. The two types of chain only vary in one thing, namely, that in one of them the rollers are all of the same size, whereas in the other type alternate rollers are of different sizes. Each roller is connected to the roller on the other side of it by two plates in such a way that a spring is enclosed between them, which, when the wheels are forced apart, is compressed, so that when the force is removed the wheels are brought back again to the correct distance apart. Experience with his first chain-track vehicle led Mr. Diplock to realise that there was need for something which would "give," but at the same time be capable of resuming its original position when the force causing it to give, and hence causing some rollers temporarily to travel faster than others, was removed. These spring roller chains were the outcome of this experience, and we gather that the consequent reduction of friction was very considerable, the rollers with vertical axes, particularly, having the effect of reducing the side friction to a marked degree. Before they were employed, the flange friction on the horizontal rolls was found to be prohibitively great.

In subsequent patents Mr. Diplock made various modifications. For instance, in patent No. 16,402 of 1913, he suspends each foot carrier on two slippers, one on each side of its axis—see Figs. 73 and 74—the weight of the vehicle being borne by a central slipper pivoted to a transverse axis on the carrier, the main roller chain lying between these main slippers and outside the main rail. Moreover, on each side of each foot carrier two pins X X¹ are provided instead of one, these pins being those engaged by the sprocket wheels, and serving to lift the slippers or rails from the roller chains. An auxiliary wheel is also provided and keyed to the same shaft as the sprocket wheel, this additional wheel being adapted to engage rollers

on the ends of the pivots B of the main slippers. The motions of the foot carriers when passing round the ends of the machine are thus controlled at points at different distances from the centre. The foot carriers are connected together in a chain of links. In the drawings A are the feet and M the foot carriers. Each carrier has pivoted to it at B, C and D, three slippers E, F and G—see Fig. 74. The upper slipper E is a wide trough, while the two lower slippers F and G have central ribs H and J respectively. These slippers are dished in the middle, as was the case in those referred to in patent No. 14,491 of 1912, and for the same reason. The framework of the vehicle has

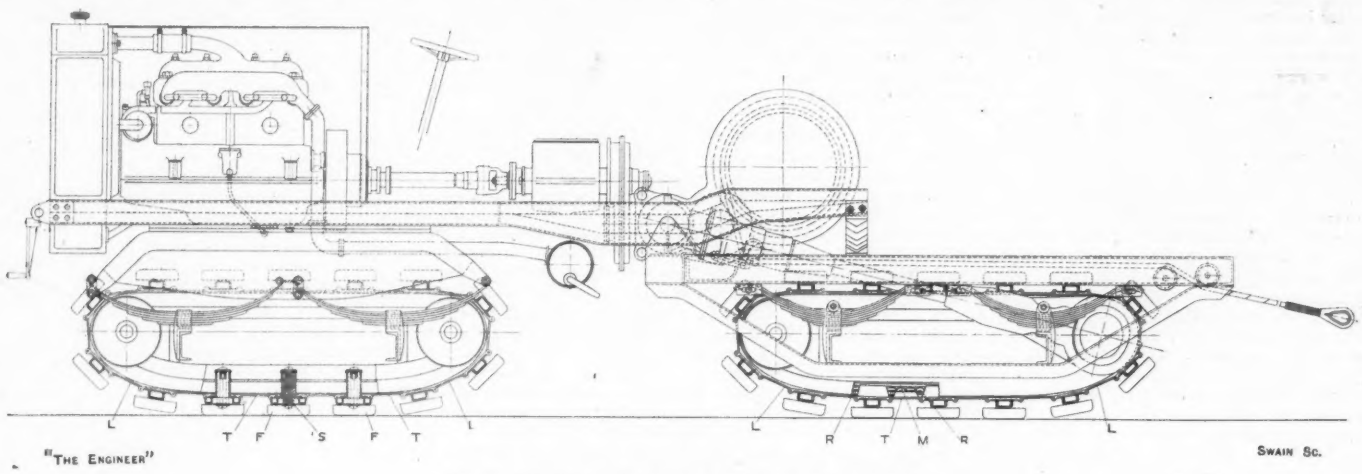


Fig. 76—PRESENT DAY DIPLOCK CHAIN-TRACK TRACTOR

fixed to it three rails N, N^1 and N^2, much in the same manner as is also set out in that patent, but the inner rail, which is endless, has fixed to its outer surface two ribs O. The rails N^1 and N^2 are trough shaped. P^1, P^2 and P^3 are spring roller chains interposed between the slippers and rails. The chain P^1 is triple, while the chains P^2 and P^3 are double.

The pivots B of the slippers E are rigidly fixed to the body of the foot carrier M, but the pivots C and D of the slippers F and G are fixed to sleeves K free to move up and down on columns fixed to the body, and springs—which are not shown in the drawings—are provided which tend to force the slippers F and G away from the slipper E, and thus to keep all the slippers in contact with their roller chains and the chains in contact with the rails. The foot carriers are connected together by chains L, which have in them spring boxes similar to those used for the roller chains. The construction of the double and single roller spring chains is so well shown in Fig. 75 that no description is necessary. Springs are, of course, arranged between adjacent rollers.

Four chain-track Pedrail vehicles are shown in Figs. 78, 79, 80, and 81, page 250, the last-named being a tractor. The dates when these were constructed are: Fig. 78, 1911; Fig. 79, 1911–12; Fig. 80, 1912; and Fig. 81, 1913. The later improvements of Mr. Diplock have all been directed towards simplification. As nearly all of them have come within the war period, we do not propose to deal with them all in detail at the present time, for the last thing we wish is to give any information to our enemies which they do not possess. It may be said, however, that the improvements effected have been considerable. For one thing, vehicles are now being made with only one rail and one chain of slippers at each side of the frame, the friction in which is remarkably small. The method of connecting the feet to the feet carriers has also been simplified and improved, so that, for example, turning has now been rendered much more easy.

The Pedrail, as now constructed, is shown in the Fig. 76, and we may repeat the three salient features in the design which are worthy of notice. First of all, springs S are introduced between the feet F and the movable part of the track T, allowing the former to take up any required position without undue stress on the mechanism. This feature is important from the consideration of wear and tear of both the road and the vehicle. In this connection it may be interesting to note that in 1905 an order was made by the Local Government Board amending the Road Locomotive Acts, to enable cars moving on feet to use the public highways. This order stipulated that the feet of such a car must not move relatively to the ground, whilst they are bearing any portion of the weight. Mr. Diplock claims that his are the only vehicles which definitely fulfil this condition, and that they do so by reason of the springs. These springs, which are placed immediately above the feet, furthermore reduce the unsprung weight to a minimum. Second, as in his earlier vehicles there is—to act as an anti-friction medium between the movable part of the track T and the rail M fixed to the frame—an extensible roller chain R. This roller chain has rollers revolving in two planes at right angles to one another; friction is thereby eliminated as far as possible. Third, the extensible roller chain enables the frame to be curved up at the ends shown at L; the sprockets are thus kept well clear of the ground. All feet that are likely to come in contact with the ground at any one moment are backed by the roller chain and the rigid frame. This feature, Mr. Diplock points out, is important on the score of speed, and equally important from the point of view of climbing obstacles.

It is the combination of the above factors that has enabled the designers of this machine to attain a remarkably good efficiency and speed. The smallest type of Pedrail machine made, viz., a one-ton trailer or wagon, is shown in Figs. 82 and 83, page 250. This trailer, fully loaded and representing a gross weight of 33 cwt., can on the level be easily pushed at a walking pace by one man. As an example of speed, we are informed that speeds of fifteen miles per hour have been obtained without undue stress on the mechanism, both on hard roads and in the open country. This trailer can be turned in a circle with a radius of 15ft. In Fig. 82 the chain-track is shown opened out for inspection. The process of opening out is performed

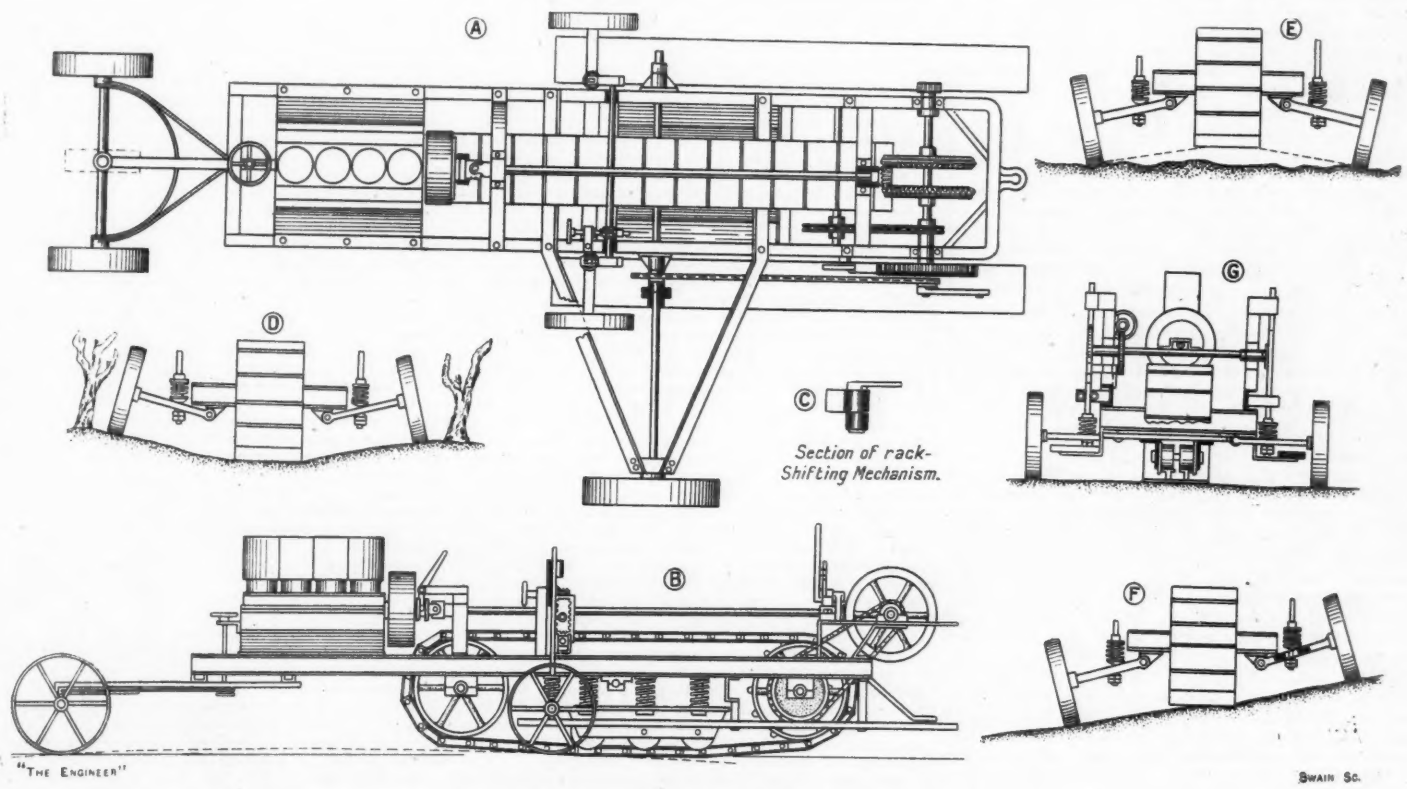


Fig. 77—THE HOLT AGRICULTURAL CHAIN-TRACK TRACTOR, 1911

away from the slipper E, and thus to keep all the slippers in contact with their roller chains and the chains in contact with the rails. The foot carriers are connected together by chains L, which have in them spring boxes similar to those used for the roller chains. The construction of the double and single roller spring chains is so well shown in Fig. 75 that no description is necessary. Springs are, of course, arranged between adjacent rollers.

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We have previously referred to the work of the Holt Manufacturing Company. It has done a great deal towards popularising the use of the chain-track tractor in the United States, having adapted it so as to make it suitable for various services. As an

example of one of its machines, we may draw attention to the drawings given in Fig. 77, which are some of those attached to the specification of the British patent No. 5857 of 1911, taken out by Mr. Benjamin Holt, of Stockton. They show a tractor designed to be employed for hauling a plough or harvester, or for use in a vineyard or orchard where a minimum width is desirable.

The main frame of the machine consists of two longitudinal girders, spaced apart by transverse girders, and having a couple of steering wheels in front, which are controlled by a hand wheel. These wheels support only a comparatively small proportion of the total weight, the major portion being taken by a central flexible endless tread-belt extending longitudinally between the two frames. This belt passes over two pulleys, the shafts of which revolve in bearings secured to the main frames. Power is transmitted to it from the engine by means of the rear wheel, which is furnished with teeth for the purpose. The engine shaft is fitted with a universal joint, so that the bevel pinion at its rear end may be made to engage with either one or other of the two bevel wheels on a shaft carried on the raised frame at the rear of the vehicle—see drawings A and B in Fig. 77.

In order to accommodate the machine to various inequalities or formation of the ground to be traversed, and to keep it upright under all conditions, side axles pivoted at their inner ends to brackets attached to the frame and furnished with bearing wheels at their outer ends are provided. These axles are adjustable so that they may be elevated or depressed so as to engage the soil, as shown in drawings D, E, F and G—Fig. 77. This adjustment is even sufficient to permit the chain track to be lifted right off the ground, as in drawing E, should such a course be desired, as, for example, when the vehicle is being taken down a falling gradient, which it would descend by the action of gravity. One method of bringing about this adjustment of the axles is shown in the drawing G. The mechanism comprises a rack bar moved in a bearing by means of a pinion, the pinion being secured on a transverse shaft, which may be revolved by means of a worm wheel, worm, and handle. The lower end of each bar passes through a slot in its corresponding axle, and has a nut at its lower end. A strong spring is arranged round each bar, and this spring reacts between a collar on the bar and the axle, thus forming a resilient bearing for the pivoted axles on each side of the engine.

In order to permit of the individual and opposite adjustment of the axles, one of the rack bars is provided with a yoke or bracket—see drawings B and G—in which is slidable a rack block mounted on a crank, which is provided with a handle. By this handle the crank may be turned so that the rack bar may be moved so as to enable one or other of two racks to mesh with a pinion. When one of these racks is in engagement with the pinion, the axles may be moved in opposite directions, whereas, when the other rack is in engagement with it, the axles will work together either upwards or downwards.

Without the big side wheel on the extension frame, to which we are now going to refer, an engine constructed on this principle actually measures less than 5ft. in width, so that it should be most convenient for use in restricted spaces such as those in vineyards or orchards. The additional side wheel is for use when the machine is hauling a plough or a harvester. The frame carrying the wheel is entirely separate and detachable from the main frame, and may be made so that it can be fastened on either side of the machine. The wheel is driven by chain from the main driving shaft in the manner shown in drawing A. The two side wheels may be dismounted when this additional side wheel is being employed, and the latter then performs two functions, viz., (*a*) it assists in driving, and (*b*) it may be used as a pinion about which to turn the machine.

We understand that about the year 1912 Messrs. Foster and Co., of Lincoln, built—we believe for export—one or more caterpillar tractors, which were similar in design to the Holt machines. The Schneider Company, of Creusot, and the Delahaye Company have, we believe, also built machines more or less of the same type. On various occasions in the intervening period between the year 1913 and the present time, we have referred to and illustrated tractors of this type, or very similar to it, made by other firms than those we have hitherto mentioned, notably the Austin Excavator Company, the Bullock Tractor Company of Chicago, and Clayton and Shuttleworth, Limited, of Lincoln. All of these machines have exhibited only slight modifications of the various arrangements which have already been described, and do not possess any really distinctive features. The Allis Chalmers Company, of Milwaukee, and the Buckeye Manufacturing Company, of Anderson, Ind., have also made chain-track tractors.

As completing our reference to the work of Mr. Lombard, we reproduce in Fig. 84, page 248, a photograph of what we believe to be the latest type of chain-track vehicle, which has been evolved within the last year or two by the Lombard Auto Tractor-Truck Corporation of New York City. It will be observed that the roller chain, which appeared in Mr. Lombard's original patent, is retained, though the rail which takes the weight of the vehicle, and between which and the chain of feet comes the roller chain, varies considerably from the original proposal, being pivoted to the frame of the vehicle, and evidently capable of swinging on its pivot. It will be seen, too, that the links of the tractor chain are all hinged together, and that this chain is lifted off the chain of rollers before it is taken round the sprocket wheel. We may add that the Lombard Auto Tractor-Truck Corporation makes several types of vehicle intended for different purposes, including ploughing, potato digging, &c., in addition to general haulage. A standard sized machine weighs 7¼ tons, has a platform 6ft. wide by 10ft. long, which is designed to carry five tons and more, and will, so we gather, not only propel that load but will, in addition, haul from two to six heavily loaded sledges or truck trailers. This machine is fitted with a four-cylinder four-cycle engine of 60 horse-power. There are three forward speeds, two, four, and six miles per hour, and a reverse. This machine will haul from four to eight ploughs, according to the depth ploughed, and the nature of the soil.

With this illustration we conclude our articles. We have specially avoided making any mention of the work of either Germany or Austria in the direction of chain-track vehicles, and we have done so, not because they are enemy countries, but because, as far as we are aware, they played no part whatever in the actual evolution of vehicles of this type, though, undoubtedly, they adapted the inventions of others to their own needs. Nor have we made detailed reference to the work of France or any other nation, for none of them has, to the best of our knowledge, added materially to the development of the chain-track mechanism. It would be hard to say exactly that any one person or firm was the actual inventor of this system of haulage. It has been gradually evolved by a great many workers, who have carried on their investigations independently, though, for the most part, on similar lines. An exception is Mr. Diplock, who alone has pointed to the necessity for having the roller chain flexible, and each foot of the chain-track absolutely free to move in any direction and within certain limits with respect to the other feet immediately adjacent to it, if the best results, as regards friction and freedom from wear and tear, are to be looked for.

In the foregoing, it is not pretended for a moment that every invention bearing on this most interesting subject has been alluded to. All that has been attempted has been to give a more or less connected narrative, showing the steps by which, gradually, workable machines were produeed, and to illustrate the progress by typical examples from the hosts of proposals which have been brought forward.

NEW EXPERIMENTS ON SHOCK TESTS AND ON THE DETERMINATION OF RESILIENCE.*

By GEORGES CHARPY and ANDRE CORNU-THENARD (Paris).

Most investigators who have published researches on bend tests of notched bars appear to have renounced all attempts to obtain a series of results devoid of accidental differences. Some attribute such irregularities to the mode of testing itself; others challenge the homogeneity of the metal under investigation.

The bend test on notched bars possesses a degree of extreme sensitiveness, which serves to reveal certain physical states not revealed by any other of the usual tests, and of which the influence, from a practical point of view, should not be neglected.

It appeared to the authors that once a question had lent itself to controversy and had been made the subject of conflicting observations on behalf of different investigators, a fresh series of measurements would always be insufficient to satisfy everyone beyond possibility of doubt. The authors conceived, therefore, that it would be an advantage to submit their own tests to a certain number of competent persons for checking, and they invited all the members of Committee 26 of the International Association for Testing Materials to be present during the carrying out of a complete series of determinations, made on the material at the laboratory of the Conservatoire National des Arts et Métiers by the staff of that institution. Their results have thus received, in some sort, official sanction, evidenced by the report of the Conservatoire, to which may be added the weight of the authority of the personages, French and foreign, who responded to the authors' invitation. These comprised :—Mr. Keelhoff, Professor at the University of Ghent; Mr. Camerman, Chief of the Testing Department of the Belgian State Railways; Dr. Stanton, National Physical Laboratory; Mr. Mesnager, Director of the Testing Laboratory of the French Government Department "*des Ponts-et-Chaussées*"; Mr. Guillery, Director of the firm of Messrs. Malicet and Blin; Mr. Belanger, Engineer-in-chief of the Paris, Lyon, and Mediterranean Railway; Mr. Cellerier, Director of the Laboratory of the Conservatoire des Arts et Métiers; Mr. Sabatier, Chief of the Metallurgical Section of the Conservatoire.

The details of the investigations presented by the authors consist of three principal portions :—

1. Preliminary definitions—definition of the regularity of the experiments and the determination of the degree of comparability of the shock test appliances employed.
2. Preparation of series of bars possessing equal resilience.
3. Determination of the influence of the different variables involved in the shock test.

I. Preliminary Determinations.

1. *Numerical Definition of the Regularity of the Experiments.*—It was indispensable to establish a numerical definition of the regularity of the experiments, as much for the purpose of guiding the authors in their research on the constitution of series of bars possessing similar resilience as to enable them to ascertain, without ambiguity, the influence of the various factors intervening in the shock test. It may be said, therefore, that the regularity of a series of determinations will be satisfactory when the value of the average divergence, or of the relative average divergence, is below some given and predetermined number. In practice it suffices if the average relative divergence remains below 5 per cent.

2. *Determination of the Degree of Sensitiveness and of the Comparability of the Apparatus Employed.*—Before proceeding, it was necessary to establish clearly that the irregularities, of which mention has been made above, were not due to the testing apparatus, but actually to the material to be tested; in other words, it was necessary to be certain that an apparatus properly constructed on satisfactory principles would always yield results mutually comparable, and likewise comparable with those given by every other apparatus fulfilling the same conditions as to design and principles.

With this object the authors have employed unnotched bars in such a way as to limit the deformation to a well-defined bend without carrying it as far as fracture, so that the small local irregularities which may subsist from one point of the metal to another do not interfere to any appreciable extent. Regularity was not attained without difficulty. The authors found in the course of this investigation the importance, from the point of view of the accuracy of the experiments, of an accurate definition of the parts in contact with the bars—the edge of the knife, the supports, &c.—and of the accurate machining of these elements. The results prove :—

1. That unnotched bars, prepared with certain precautions, give, when made with the same apparatus and under similar conditions, results which are practically identical, and

2. That the irregularities displayed by different notched bars, when submitted to the shock test, are attributable, not to the testing machine, but to the material itself under test.

II. Preparation of Series of Bars having Equal Resilience.

A. *Preliminary Tests.*

1. *Taking Metal Samples.*—The authors have sought to avoid, as completely as possible, the occurrence of chemical or physical heterogeneity in the metal, by removing a relatively small fragment of metal from the sound portion of a very large ingot.

The general mass of metal, an ingot of 45 tons weight, appearing to possess a satisfactory degree of homogeneity, parallelopiped strips of 100 × 100 × 300 mm., from the portion concentric with the axis and from the median part of the ingot.

2. *Influence of the Superficial Layers.*—Each strip A, rolled into a square bar 34 × 34 mm., furnished one series of test-bars.

The test-bars were then annealed to remove the stresses due to rolling, machined to the dimensions 30.5 × 30.5, and submitted to heat treatment, that is quenching and annealing.

In spite of all the precautions taken the authors still found all the irregularities so often noticed in resilience tests while finding the hardness practically constant in the different bars, and felt led, by certain observations, to ask themselves whether, during the course of the treatments to which the metal had been subjected, the superficial layers of the test-pieces might not have undergone certain modifications capable of influencing, in some appreciable manner, the results of the shock test; to verify this conclusion they had recourse to planing the lateral faces of some of the bars and submitting them to shock tests. The experiments appear conclusive: simply planing the lateral faces made the relative average divergence fall from about 40 per cent. to 8 per cent., while the hardness tests applied to the surface revealed on the contrary no similar variation and remained perfectly regular. One of the first conditions to be fulfilled in securing homogeneous results in a series of shock tests, is therefore to eliminate the superficial layers of the bars after treatment.

3. *Influence of the Temperature of Rolling.*—Furthermore, some experiments carried out on another steel led the authors to believe that the temperature of rolling might influence resilience. In order to ascertain the extent of this influence they had two blocks rolled from their 45-ton ingot, one at about 1200 deg. Cent., and the other at about 800 deg. Cent. The bars thus obtained were annealed at about 900 deg. Cent. and cooled in the furnace. On removal the bars were quenched and annealed, then machined to the dimensions of 30 × 30, punched, and notched.

The authors had assumed that the more or less pronounced interstraining produced during the course of the rolling or of the forging would be completely removed by a suitably selected further heat treatment; but the results showed that if this be really so in regard to the ball tests, it is not true as regards resilience tests, though not even micrography could reveal, after the treatment, any difference between the structure of the cold-rolled metal and that of the hot-rolled metal.

4. *Influence of Inaccuracy in the Heat Treatment.*—These first results having been secured, the authors sought to eliminate the influence of the surface layers and of the rolling temperature by operating as follows :

A new block of metal was transformed by rolling into a bar of 35 square millimetres; this, after undergoing a first annealing, was cut up into portions capable of being rolled into bars of 160 mm. in length. These portions were themselves subjected to heat treatment—quenching and annealing—in the conditions described above and then trimmed to the dimensions of 30 × 30, punched, notched, and tested. The series was thus composed of five consecutive lengths cut from the same bar. The results of a number of determinations showed maximum divergencies of 18.57 to 13.81, and did not attain to the degree of uniformity sought by the authors. It appeared to them at this juncture that the carrying out of the heat treatments might leave something to be desired, and they therefore decided to effect the heating by treating all the bars of a single series simultaneously in a bath of lead.

The experiments carried out under these conditions displayed superior uniformity to those previously obtained.

B. *Determinate Experiments.*

1. *Description of Results.*—It remained to confirm the

* Iron and Steel Institute. Abstract.

results obtained by checking their accuracy over a certain range in the scale of resiliences. For this purpose the authors took blocks of a metal which was semi-hard and contained nickel—weight of original ingot = 25 tons—and of another metal which was hard and contained chromium-nickel—weight of original ingot 2.5 tons—which were both made to undergo the series of operations described in the previous sections.

2. *Conclusions.*—The results showed that it is possible to obtain, in the course of experiments in resilience tests carried out on bars of steel of different natures, or on copper a degree of uniformity analogous to that obtained by means of tensile or of hardness tests.

On the other hand, the course of the experiments previously detailed clearly invalidates the opinion of certain authors, adherents of the employment of a V-shaped notch, according to whom the sensitiveness of the shock test is appreciably diminished by the use of the cylindrical notch known as the Copenhagen notch. The authors find, indeed, that given the same metal with the same form of bars notched cylindrically, that the test numbers are grouped in perfectly concordant groups when the precautions are properly taken, and into discordant numbers in the opposite case. The degree of uniformity attained is not therefore due to defective sensitiveness, for this, in the two alternatives, remains the same, but rather to an improvement in the method of preparing the material to be tested.

These preliminary observations being made, the authors are now able to sum up briefly the whole of the precautions which they were led to take to form the series of uniform bars. (1) It is obviously necessary to select a sample of homogeneous metal by removing it from the soundest portion of the ingot; (2) it is necessary to eliminate the outer layers of the test bars after heat treatment. The surface perturbations are more or less marked according to the nature of the metal. The authors have adopted, as a general rule, bars of 35 × 35 mm. as a starting point, for the preparation of bars measuring 30 × 30, and of bars of 15 × 15 mm. for the preparation of test-pieces measuring 10 × 10 mm. (3) The temperatures of rolling and forging should, for any one series, be as similar as possible. In particular, it is desirable, in any one bar, to make as large a crop as possible at each end in order to eliminate the portions which may have undergone abnormal cooling in the course of hot-working. (4) It is absolutely necessary to carry out the heat treatments under the most uniform and accurate conditions attainable.

III. Influence of Different Variables which may Intervene in Shock Tests.

Being possessed of very homogeneous material able to give results extending over the entire scale of ordinary resilience, the authors were in a position to study the influence of the different variables which are capable of intervening in the course of shock tests. It was no longer necessary to take into consideration, each time, a large number of more or less discordant results and to take the means by invoking the application of the law of averages. They were therefore able to remain content in the course of the experiments, with breaking at least five bars per experiment.

1. *Influence of the Height of Fall.*—The influence of the height of fall of the drop-weight in shock tests is often considered as exerting an important share in the results; it is, however, regarded with widely varying views. Mr. Belanger, for instance, claims decreasing resilience from unity to double and even more when the height of the fall is reduced from 4 m. to 1 m., while, on the other hand, Mr. Fremont gives differences in respect of certain steels which, although not numerically recorded, he appears to regard as even more excessive than those recorded by Mr. Belanger, but in the opposite direction entirely.

The tests by the authors were carried out on two different pendulum drop-weight machines, one having a maximum height of fall of 6.45 m. and the other 3.87 m., the bars, which measured 30 × 30 × 160 being notched with the Copenhagen notch. The results showed that the rate of shock is practically negligible within the limits to which the authors confined themselves—11.25 m. to 3.40 m.—and which do not exceed those of the appliances generally employed in the testing laboratory. The indifference displayed by the results of the shock test to the height of fall is easily understood, under ordinary conditions, if instead of considering rate of impact—or height of fall—the mean rate of deformation be taken into consideration.

2. *Influence of the Weight of the Drop-weight and that of the Anvil-base.*—In view of the difficulty in accurately defining precisely what is meant by the expression "weight of anvil-base," the authors decided to institute comparisons between two machines of the same type, differing, however, considerably in their dimensions; the question of height of fall being eliminated, the two only variables whose influence could affect the results were thus the weight of the drop-weight and of the anvil-base. With this object in view two pendulum drop-weight machines were employed, one of 307 kilogrammetres—weight of drop-weight, 96.25 kilos.; height of fall, 3.87 m.; and distance apart of supports, 80 mm.—and the other 47 kilogrammetres—weight of drop-weight, 32.14 kilos.; height of fall, 1.49 m.; and distance apart of supports, 80 mm.

However, as the pendulum drop-weight machine of 47 kilogrammetres employed was one of an old pattern and appeared to have suffered some deterioration in the course of these experiments during which somewhat heavy demands were made upon it, the same experiments were repeated on a new machine, the dimensions of the test-bars being reduced to 15 × 15 × 80 mm. In this second series of experiments the authors employed: (1) the same pendulum drop-weight machine of 307 kilogrammetres as described above (distance apart of supports, 60 mm.); (2) a 30-kilogrammetre pendulum drop-weight machine (weight of drop-weight, 22.31 kilos.; height of fall, 1.45 m.; distance apart of supports, 60 mm.). The weights of the frames of these two machines were 1800 kilos. (the 307-kilogrammetre machine) and 190 kilos. (the 30-kilogrammetre machine) respectively. It may be assumed that the weights of the anvil-bases are roughly proportional to those of the frames.

In this case the homogeneity of the individual determinations in each series was thoroughly satisfactory, and the average resiliences did not differ from one another by more than 0.74 kilogrammetre, that is, say, by only 3.9 per cent. of the highest figure recorded. It may therefore be concluded that, within the limits of accuracy reached in these experiments, the weight of the drop-weight and that of the anvil-base are without effect on the drop-test result. These results appear to the authors the more interesting in that, in these experiments, the two machines worked under altogether abnormal conditions; the large machine being unduly large for the work and the small machine unduly small. Thus, while in the former the breakage of the test-bars barely absorbed one-tenth of the available energy, in the latter nearly the entire energy of the machine was absorbed.

3. *Comparability of Different Types of Machines.*—Having thus established the practical identity of the results obtained on shock testing with two machines of the same type, although differing considerably from one another in dimensions, the authors set themselves to investigate whether the different types of machines in use gave comparable results.

(*a*) *Pendulum Drop-weight and Vertical Drop-weight (falling weight) Machines Compared.*—Their first experiments related to a pendulum drop-weight and a vertical drop-weight machine. It was natural, therefore, in the first place, to seek to ascertain if, qualitatively speaking, comparable results were obtainable. Preliminary tests proved that from a qualitative point of view, the pendulum drop-weight and the vertical drop-weight machines were perfectly comparable; it remained therefore to estimate numerically this comparability. For this the authors fixed on the vertical drop-weight machine an Amsler-Laffon recorder, which allows of the exact determinations of the rate of speed before and after fracture, and enables the energy absorbed in fracturing the bars to be calculated accordingly. The bars employed were of the Copenhagen type and measured 30 × 30 × 160 mm. In both machines the distance apart of the supports was 120 mm. The two average resiliences obtained differed from one another only by 0.74 kilogrammetre, or, in other words, by 7.1 per cent. of the higher figure. Given the makeshift nature of the arrangements the results obtained with the vertical and with the pendulum drop-weight machines may be regarded as being in close agreement.

(*b*) *Pendulum Drop-weight Machines and Rotary-weight Machines.*—The experiments carried out at the Conservatoire des Arts et Métiers were made with Charpy drop pendulum machines of 300 and of 30 kilogrammetres, with a vertical drop-weight machine and with Guillery rotary machines of 275 and 60 kilogrammetres. The results were practically identical, notwithstanding the essential difference in principle which characterises the two types of machine.

It may therefore be concluded that the resiliences obtained on a given bar are practically identical, whatever, within the limits of ordinary practice, the height of the fall, the mass of the striking weight and of the anvil-base, and the type of apparatus employed. In order to render uniform the results of shock testing on any given bar it suffices to fix, beforehand and arbitrarily, certain material conditions, such as the distance apart of the supports, their contours, and the form of the knife-edges.

4. *Influence of the Type of Notch.*—The preceding experiments were carried out on test-bars of the Copenhagen type or on its immediate derivatives, the shape and dimension of the notch not having been as yet universally adopted. It appeared useful therefore to determine the influence of these conditions on the value of the energy of fracture per square centimetre. With this object the authors experimented, therefore, on bars of 10 × 10 × 53.3 mm., and adopted the four types of notches described below: (*a*) Round notch: Residual section 10 × 5 = 0.5 punched with a die and saw notched. (*b*) Round notch: Residual section 10 × 7 = 0.7 punched with a die and saw-notched. (*c*) Angular notch: Residual section 10 × 7 = 0.7, made with a tool and planed. (*d*) Residual section 10 × 9 = 0.9, made with a blunt saw.

These results bring out the following facts: Leaving out of consideration for the moment the angular notch, the resilience increases, for non-brittle metals, when the depth of the notch diminishes; it even doubles, with highly resilient steels, when we pass from a notch of mid-thickness to one of only 1 mm. in depth. With brittle metals the resilience varies very little with variations in the depth of the notch.

If the angular notch be considered, it is found that for non-brittle metals it yields results analogous with those obtained with a deeper round notch; for brittle metals the results are lower.

These experiments, which are confirmed by the determinations carried out at the Conservatoire des Arts et Métiers, emphasise the importance of an exact definition of the notch in classifying metals in the scale of resiliences. They show how some experimenters, testing brittle metals only, have been led to the conclusion that, given bars of the same size, the area of the surface of fracture was a matter of indifference. They show, besides, how other experimenters who have exclusively used very superficial notches, have attributed to ordinary metals resiliences greatly exceeding those generally credited to steels of the same grade.

It is therefore indispensable to employ only perfectly defined types of test-bars: from a scientific point of view, in order to be able to compare the results obtained in different laboratories; from a practical point of view, in order, should need arise, to introduce into specifications factors having a precise signification.

The majority of experimenters unite in agreeing that the notch should have a definite geometrical form; it remains, therefore, to decide the depth and the radius. It certainly seems, judging from the results shown above, and in consideration of the advantage arising from strictly localising the fracture, that preference should be accorded to deep notches. The influence of the radius of the cylindrical orifice would appear to be of quite secondary importance.

5. *Influence of the Dimensions of the Test-bars and the Application of the Law of Similitude to Shock Tests.*—It would obviously be desirable to adopt a single standard of test-bar for the study of metals under shock; but this solution conflicts in practice with genuine difficulties which lead to the need of several types of test-bars of different dimensions as are used, for instance, in tensile tests.

It is necessary, under such conditions, to ask whether, for a given metal, any simple relationship exists between the resiliences as determined on test-bars of different shapes. It had been thought, in the first instance, that in order to obtain comparative results it would suffice to employ notched test-pieces of geometrically similar shapes. But experience decisively invalidates this view and shows that the resilience, even in the same metal, varies to a considerable extent according to whether it be determined on test-bars measuring 30 × 30 × 160 or on test-bars measuring 10 × 10 × 53.3. This variation always takes place in the same direction, whether the metal be steel or copper, the resilience increasing with the dimensions of the test-bars. The ratio between the results itself undergoes modification, rising from $\frac{3}{4}$ for the least brittle steel to $\frac{4}{5}$ for the most brittle, and to $\frac{5}{6}$ for copper. This fact has, indeed, been noted by many observers of various nationalities who have carried out, independently of one another, numerous experiments which agree completely, as is shown in the report presented by one of the present authors at the New York Congress in 1912.

A theoretical investigation published in 1911 by Captain Mimey concludes, from the point of view now under discussion, that the deformation of the bending test-bars B_1 and B_2, whether notched or not, and geometrically similar according to the similitude relation a will absorb T_1 and T_2 energy which will be to each other as the cube of the homologue dimensions, if the striking weights M_1 and M_2 of the drop-weight machines, the heights of fall H_1 and H_2 and the distances between supports D_1 and D_2 comply respectively with the conditions:

$$\frac{M_1}{M_2} = \frac{\sqrt{H_1}}{\sqrt{H_2}} = \frac{D_1}{D_2} = a.$$

This is, therefore, the ratio sought between the resiliences R_1 and R_2.

The authors' experiments appear, unfortunately, to foreshadow that this ratio, seductive as it is by reason of its simplicity, does not conform in a satisfactory manner to the conditions in practice. It has been brought out, in the course of this paper, that the work absorbed by the fracture of a test-bar is independent both of the mass of the falling weight and of the height of fall, or, in other words, that the kinetic energy absorbed was practically independent of the kinetic energy available, and of the rate of speed of the weight at the moment of impact. The supplementary conditions introduced by Captain Mimey are insufficient therefore, *a priori*, to secure the comparability of the resiliences obtained on two similar test-pieces. The authors have verified this on many occasions. They confine themselves, in the present instance, to giving the results of two series of determinations made, one on copper, the other on a special steel P. These two metals were selected in order to secure as complete as possible a degree of homogeneity in regard to internal structure.

The operations were conducted in the following manner: The authors had at their disposal two pendulum drop-weight machines geometrically similar, the falling weights of which were respectively 96.250 and 32.140 kilos. To cause these two machines to work in the conditions required by similitude it was only necessary to give the first-mentioned pendulum a fall through an angle of 160 deg. and to allow the second to fall through an angle of 58 deg.

There were then broken, on the larger machine (angle of fall 160 deg.), five test-bars measuring 30 × 30 × 160 (cylindrically notched half-way through with a notch 4 mm. in diameter) and forming a series of equal resilience. There were then selected, arbitrarily, the fragments of two of these test-bars, from which were made six test-bars of 10 × 10 × 53.3 (notched with a cylindrical notch 1.3 mm. in diameter, to one-half the thickness of the test-bar) taken from the larger bars. This mode of preparing the smaller test-bars (one, centrally from one of the pieces; the two others from nearer the surface of the other piece) was selected in order to be able to verify, simultaneously, the perfect homogeneity, in point of depth, of the metal tested. These six test-pieces were broken on the smaller pendulum drop-weight machine (angle of fall 58 deg.).

The figures obtained showed clearly: (1) That the internal homogeneity of the metal is satisfactory, seeing that the little test-pieces *a* and *b* behave precisely similar to the little test-pieces *c*; (2) that the resiliences given by the test-bars of 10 × 10 mm. differ distinctly from the resiliences given by the test-bars of 30 × 30 mm.

It is therefore justifiable to state that the law of similitude does not apply in the case of shock tests on notched bars.

Captain Mimey's conclusions are, however, applicable when a deformation is produced by shock—without proceeding as far as fracture—in bend tests without notches. For example, the deformations affect solely the volumes of the bars and may be, amongst each other, as the cube of homologous dimensions. But, as one of the present authors has already observed, if the operation be carried as far as fracture, there would have to be introduced, in addition, the work absorbed by the separation of the two halves of the test-bar, work which may, at first sight, be regarded as proportional to the square of homologous dimensions. It would thus become a bi-terminal formula which would have to be introduced here, of the form

$$ax^2 + \beta x^3$$

to take accurate account of the phenomenon. In any case experiments undertaken with a view to verifying this mode of regarding the matter have not as yet yielded results sufficiently decisive to justify definite conclusions. They seem, indeed, to indicate that the complexity of the nature of the relation sought is even greater than the formula cited.

7. *Conclusions.*—The authors have been led, in the course of this investigation, to seek for a degree of accuracy that would obviously have no justification in practice, where it is, in most instances, only necessary to find out whether a metal is or is not brittle, and where a knowledge of the resilience is, within 1 or 2 per cent., of little importance.

It was, however, useful to carry out, at least once, groups of very uniform experiments in order to solve, with the greatest possible degree of accuracy, a whole host of unanswered questions which have accumulated during the last ten years or so, such, for example, as the influence, on the shock test result, of the rate of impact, the weight of the drop-weight, &c.

Generally speaking, the authors believe they have shown clearly that the measurement of resilience is suscep-

tible of a degree of accuracy similar to that obtained with current tests in the metallurgical laboratory, such, for instance, as those of tensile strength and hardness. Having attained to this degree of accuracy, the traditions on the strength of which attempts have been made to impose manipulative details not susceptible of technical justification have been seen to fade away.

They have likewise shown that shock tests on notched bars possess no direct relation with other common tests, and that they are infinitely more sensitive to the influence of certain peculiarities in the working of metals. If, as now appears to be infinitely probable, if not indeed fully demonatrated, these influences act similarly on the way steel behaves in its various applications it would certainly not be right to neglect methods of investigation capable of throwing light upon them.

Being in possession of a homogeneous material the authors have been able to study, by means of obtaining in each particular instance, a small number of properly classified results—usually five—the influence of the various factors intervening in the shock test. They have thus been able to draw a series of conclusions which may briefly be summed up as follows :

1. The shock test machines of different types—pendulum drop-weights, vertical drop-weights, and rotary drop-weights—and of different dimensions employed by the authors give, in regard to resilience, results which are practically identical, given that uniform conditions are complied with as to the distance between supports and the radii of the supports in contact with the bar during testing. For the latter they have adopted a radius equal to that of the cylindrical portion of the notch (Copenhagen type) made in the corresponding test-bar (that is, $r = 2$ mm. for bars 30×30 mm. and 0.6 mm. for bars measuring 10×10 mm). They have also recognised the necessity of giving them the most careful machining and fitting in order to avoid the introduction of appreciable perturbations in the regularity of the experiments.

It is not therefore necessary, in order to obtain comparable results, to fix *a priori* on a special type of drop-weight ; it is enough to employ well-made and carefully-calibrated machines of sizes within the limits of those usually employed. The correspondence between the scales of any two given machines, or the time factor, in any one particular machine can be calculated numerically by a calibrating experiment, which may be a simple bend test on an unnotched bar, the carrying out of which, under excellent conditions as to regularity, is easy.

2. The quantitative value of the resilience can only be formulated if, at the same time, the shape and dimensions of the bar and of the notch be given. The law which would permit of deductions being drawn, from the resilience as measured, for a given metal on bars of different dimensions, is not, as yet, known.

A NEW GERMAN BATTLE-CRUISER.

ACCORDING to a Berlin telegram, a large cruiser was launched at Danzig on Saturday, the 15th inst., and named the Graf von Spee. This may be the vessel authorised under the normal estimates for 1914 as the Ersatz Viktoria Luise, as it was reported in July of that year that the contract had been awarded to the Schichau firm at Danzig. On the other hand, it seems improbable that the vessel would have been three years on the building slip. The Graf von Spee may, therefore, be one of the capital ships of the war programme, and, in any case, the announcement of her launch is interesting, for it dispels the widely held idea that for the past two years or more German naval construction has been confined entirely to submersible craft.

We have no means of ascertaining how the experience of actual warfare has influenced the views of German designers, but the possibility that this ship was laid down after the retirement of Grand-Admiral von Tirpitz from the Ministry of Marine suggests that she may have been designed on principles which differ from those advocated by the late Naval Secretary. Herr von Tirpitz, as is well known, strongly favoured a medium armament for capital ships, and it was under his direction that all the Dreadnought battleships laid down before 1913 were armed with 11in. or 12in. guns. The German battle-cruisers building at the outbreak of war were to carry eight 12in. guns, while the preceding ships carried ten 11in. We do not know whether German experts still retain their faith in medium guns, but from the semi-official accounts of the Dogger Bank and Jutland engagements published in their Press, it did not appear that either of these actions had convinced them that the inherent superiority of the larger calibre pieces mounted in the British Fleet was sufficiently pronounced to justify the great displacement and sacrifice of armour necessitated by the adoption of such guns. Nevertheless, the large cruiser—which in German naval nomenclature signifies battle-cruiser—just launched at Danzig, is understood to be armed very heavily. A report published in Washington twelve months ago on the ships of war then building in Germany credited all the capital ships, battleships and battle-cruisers alike, with a 15in. armament, and, if it is accurate, the Graf von Spee, presumably, mounts eight of these weapons. The 10in. armour belt of the Von der Tann was increased to 11in. in the "Moltke" class, and to 12in. in the Derfflinger. In the American report alluded to above, the Hindenburg was given 14in. armour on the water-line and 12in. on the gun turrets. Extremely stout protection has been a distinctive feature of all German battle-cruisers, and doubtless the Graf von Spee is no exception to this rule.

If this vessel is completed without undue delay, she ought to be in commission before the end of next year. Owing to the intense secrecy observed by the Germans with regard to their losses at Jutland and in other engagements, it is impossible to estimate with any certainty the present strength of their battle-cruiser squadron, but there is no reason to believe it comprises more than six units, if as many. As we have remarked, the news of the launch of the Graf von Spee at Danzig is mainly interesting as an indication that Germany has not wholly abandoned the building of capital ships in favour of submarines.

ON THE CRITICAL SPEEDS OF LOADED SHAFTS.

By W. M. WALLACE.

FURTHER EXPERIMENTS.

THE following experiments were arranged for the purpose of examining (*a*) the accuracy of various simple methods of determining the whirling speed of a shaft of variable section, and (*b*) the effect of radial clearance at the bearings on the whirling speed.

The graphical method of estimating the whirling speed of a shaft of variable section was the subject of an article contributed to THE ENGINEER, June 23rd, 1916, where its approximate accuracy was demonstrated for the symmetrical shaft shown in Fig. 1, when loaded at the middle with a single disc load of approximately 256 lb. weight. In this simple case there was, of course, no appreciable gyroscopic action on the shaft. In the test to be now described two similar cast iron disc loads were fixed symmetrically on this shaft in the positions shown in Fig. 1. The shaft was supported at the sections A A by simple cast iron bearings, a section of one of which is shown in Fig. 2 and an elevation in Fig. 3. The surface of contact of shaft and bearing was thus limited to a ring of $\frac{1}{4}$in breadth, and as the shaft was a nice turning fit in this ring the positions of the nodes were known almost to $\frac{1}{8}$in.

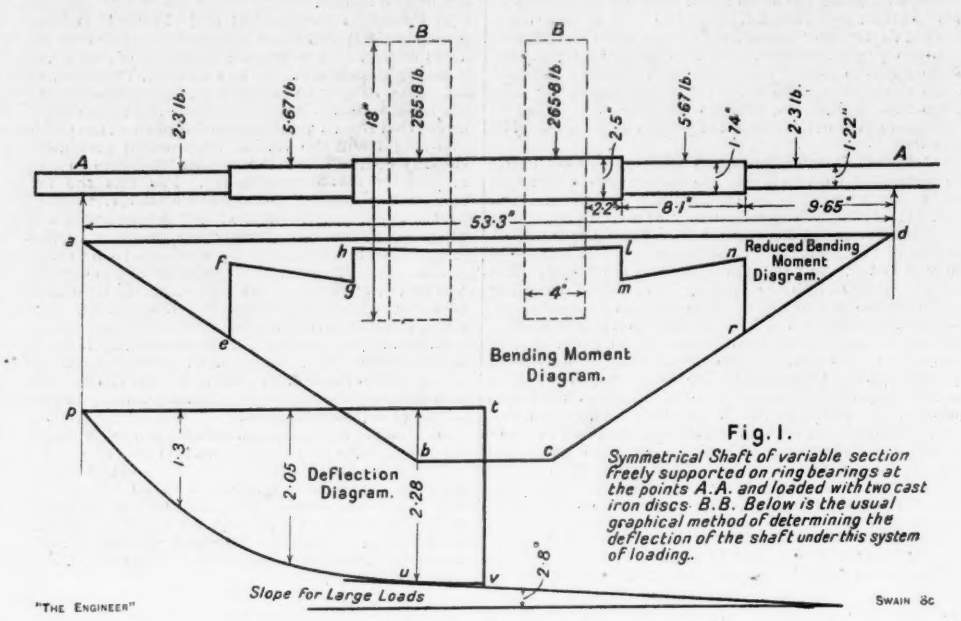
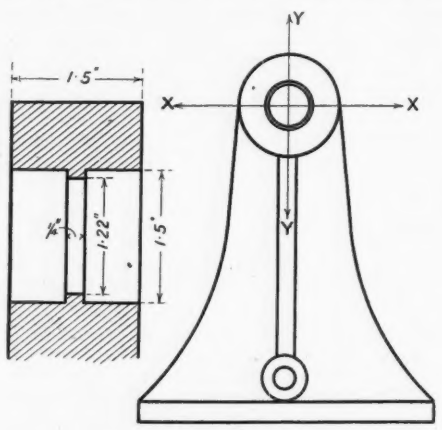


Fig. 1.
Symmetrical Shaft of variable section freely supported on ring bearings at the points A.A. and loaded with two cast iron discs B.B. Below is the usual graphical method of determining the deflection of the shaft under this system of loading.

The graphical method of obtainung the whirling speed of such a shaft is too well known to require description in full here. The bending moment diagram for the loaded shaft is shown by the figure *a b c d* (Fig. 1) and the diagram reduced to suit the smallest section of the shaft in the figure *a e f g h l m n r d* ; the deflection diagram—half only of which is shown—in the figure *p v t*. The respective loads and corresponding deflections may be tabulated as follows :—



Figs. 2 & 3.
Section & Elevation of Bearing for Shaft shown in Fig. 1.
"THE ENGINEER" SWAIN Sc.

W		y		Wy		Wy^2
2·3	...	1·30	...	3·00	...	3·90
5·67	...	2·05	...	11·62	...	23·82
265·8	...	2·28	...	606·02	...	1381·68
		Total	...	620·64	...	1409·40

Load scale 1in. = 50 lb., linear scale 1in. = 5in., polar distances 8.3in. and 4in., distance between equidistant ordinates of the reduced bending moment diagram = 0.484in., I (for smallest shaft section) = 0.1091, E = 28.06×10^6,

$$\therefore Z = \frac{50 \times 5^3 \times 8.3 \times 4 \times 0.484}{28.06 \times 10^6 \times 0.1091} = 0.03281$$

(Z is the factor by which the deflections of the shaft, as measured on the drawing, must be multiplied in order to obtain the actual deflections). Neglecting gyroscopic and bending actions, then the whirling speed is given by—

$$N = \frac{30}{\pi}\sqrt{\frac{386.4 \times 620.6}{0.03281 \times 1409.4}} = 687.5 . \quad (1)$$

To allow for gyrostatic action we have the slope for the large loads $\theta = 2.8$ deg. (as measured); the actual slope, however, is

$$2.8 \times 0.03281 \times \frac{1}{5} \times \frac{3.1416}{180} = 0.009772 \times 0.03281$$

radians ; $k^2 \doteq 22$ approx.

$$\therefore W k^2 \theta^2 = 265.8 \times 22 \times (0.009772 \times 0.03281)^2 = 0.5584 \times 0.03281^2.$$

The quantity to be subtracted from the value of $\Sigma W y^2 = 1409.4$ in the denominator of equation (1), in order to correct for gyroscopic action, is 0.5584. Working with four figure log. tables—quite accurate enough for this purpose—no appreciable difference is seen in the result. So much for gyroscopic action !

On actually running this shaft it commenced to whirl at 663.6 revolutions per minute, and continued until a speed of 680 revolutions per minute was reached ; the maximum whirl, as indicated by levers—see Fig. 4—attached to a support near the shaft, occurred at a speed of 677 revolutions per minute ; or at about 1.5 per cent. below the speed as calculated above. The difference may be due to experimental error, though it is most probably due to the slight difference in diameter of shaft and bearing ; a difference which must always occur where a shaft turns freely in its bearing.

We will next compare these values with the whirling speed as given by the rapid approximate method using the deflection tables for a uniform shaft—THE ENGINEER, August 11th, 1916—and the formula for the correspondingly loaded variable section shaft—THE ENGINEER, September 1st, 1916. We will first find the whirling speed for a uniform section shaft 1.22in. diameter loaded as above. Assuming the shaft divided into twenty equal lengths between the points of support A A, it will be seen that the loads are situated on the eighth and twelfth divisions respectively—or thereabouts—and referring to the deflection table we find the deflection constants to be 192 and 181. The deflection under each load is therefore—

$$\delta = \frac{(181 + 192)\ 265.8^3}{10{,}000} \times \frac{L^3}{E\ I}$$

L = 53.3in. (length of shaft) ; $I = \frac{\pi (0.61)^4}{4}$;

$E = 28 \times 10^6$; $\delta = 265.8 \times 9.914 \times 0.04972 = 265.8 \times 0.4929$; and

$$N = \frac{30}{\pi}\sqrt{\frac{386.4}{0.4929}} = 267.2 \text{ revolutions per minute.}$$

To obtain next the whirling speed for the shaft of variable section we use the formula—

$$N_v = N_u \sqrt{\frac{b^3}{1 + \frac{a^3 - 1}{x} + \frac{b^3 - a^3}{y}}}.$$

$a = \frac{17.75}{9.65}$ (see dimensions on shaft—Fig. 1),

$b = \frac{53.3}{19.3}$; $x = \frac{I_2}{I_1} = \left(\frac{1.741}{1.221}\right)^4 = 4.130.$

$y = \frac{I_3}{I_1} = \left(\frac{2.50}{1.22}\right)^4 = 17.57.$

$$N_v = 267.2 \sqrt{\frac{21.05}{1 + \frac{5.224}{4.130} + \frac{14.83}{17.57}}}$$

= 695 revolutions per minute.

It is known that this method tends to give results on the high side, so that the correct theoretical whirling speed of this shaft—neglecting clearance—appears to be about what the graphical method indicates, or 688 revolutions per minute.

A notable feature of these experiments—both with and without bearing clearance—was the difficulty experienced in obtaining a true whirl of the shaft. Under the action of the hammer blows along the line X X—Fig. 3—the cast iron stands—which are fixed at the base to a massive iron bed—yielded slightly, with the result that on speeding up the shaft horizontal vibrations first made their appearance, which

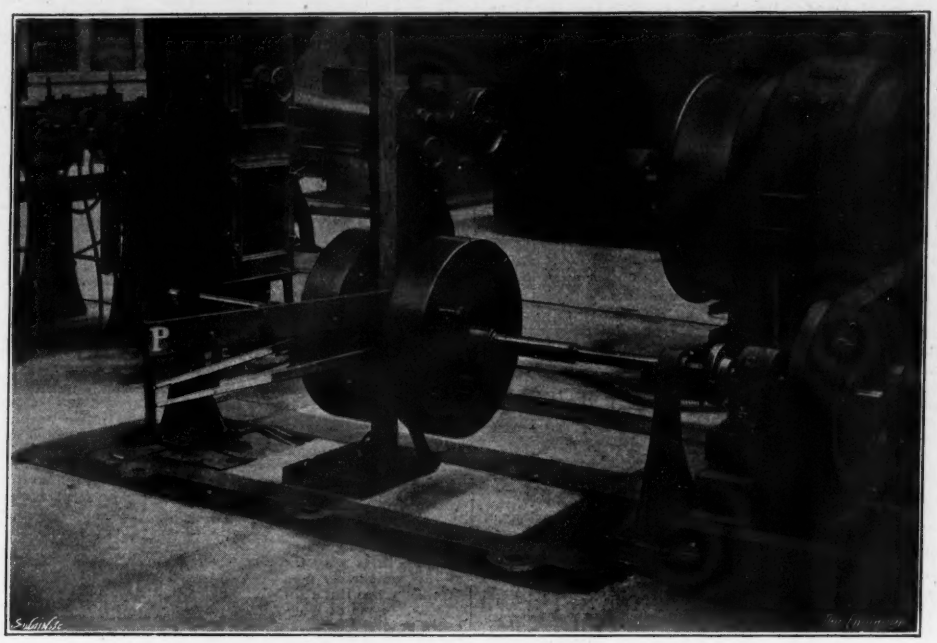


Fig. 4—ARRANGEMENT OF THE EXPERIMENTAL APPARATUS

died down as the speed was increased, to be succeeded by vertical vibrations. This experience suggests the possibility that, since it is unlikely that the clearance and yield of bearings is rarely the same in these two directions, the shafts of most machines do not whirl at any speed, especially if the noise produced is considerable.

EFFECT OF BEARING CLEARANCE.

In order to examine the effect of radial clearance at the bearings the shaft was dismounted and the ends turned down at the sections of support A, as shown in Fig. 5, thus forming a diametral clearance of 1.220 − 1.176 = 0.044in. A simple theory taking into account radial clearance was given in THE ENGINEER, September 1st, 1916. This theory anticipated that the clearance would lower the whirling speed and increase the range of speeds over which whirling would occur.

The leading lines of the theory may be indicated by a reference to Figs. 6 and 7, which purport to show an extremely thin shaft whirling with a radial clearance β at the bearings. The deflection of the shaft at any given point being y, the potential or strain energy stored in the shaft is proportional to y, but the radius of the circle of whirl described by the shaft at this point being $y + \beta$ it follows that the kinetic energy of motion is proportional to $(y + \beta)^2$; that is, instead of using the summation of $W y^2$ in the denominator of the expression for N it is necessary to use the summation of $W (y + \beta)^2$. This, of course, results in a lower value of the whirling speed being obtained. It should be carefully noticed, however, that this case differs very materially from that in which there is no radial clearance. In the latter case there is, theoretically at any rate, a definite speed at which whirling will occur, but in the former there is a whirling speed for each assumed extent of deflection of the shaft, and the whirling speed is calculated on this assumption. If the speed of rotation of the shaft is being increased the increased centrifugal forces due to this augment the magnitude of the whirl, and as the whirling frequency increases with this amplitude it is to be expected that whirling will be maintained over a considerably greater range of speeds. This is fully borne out in practice.

In the case of no clearance the values of y corresponding to the deflections of the shaft under the static loads are taken merely as a convenient means of obtaining the approximately correct ratios between them—the actual magnitudes having no influence on the result—so that when we use the same deflections for the other case it must be borne in mind that we are simply estimating a speed at which—if the out-of-balance forces are sufficiently large—some lateral disturbance might begin. We say some lateral disturbance because for a horizontal shaft whirling will not commence at this speed unless the rhythmically applied vertical components of the centrifugal forces are sufficiently large to generate such vertical momentum in the shaft as will lift it bodily against its dead weight through the clearance distance.

It will be observed that the ideal conditions sketched in Fig. 6 only hold for a vertical shaft. That these considerations are important is very evident to anyone who closely observes the motion of such a shaft in its bearings when the speed of rotation is gradually increased. As the speed of rotation is slowly increased the first disturbance to be noticed is always a horizontal one; the shaft commences to vibrate in a horizontal direction; the direction in which the only external-force resistance to motion is the friction at the bearings. It will then hammer at the bearings through a considerable range of speeds before any vibration in a vertical plane is observable.

It is obvious to the experimenter that not only are the magnitudes of the out-of-balance forces on the shaft important in affecting the speeds and the amplitudes of vibration or whirl, but that their disposition on the shaft is too. In most cases in practice it is a single force situated near the middle of the shaft, a case for which the simple theory indicated above is applicable; still it is easy to conceive a case in which the clearance effect would only be realised at one end or bearing.

The more one studies the actual behaviour of shafts the more one realises how inadequate, even misleading, is the usual mathematical treatment of the problem. In his mathematical investigation into the effect of gravity Mr. Kerr deduced a new whirling speed some 30 per cent. below the usual theoretical result, which agreed with the result he obtained actually on the shaft of an electrical generator. That low actual result must have been due to clearance at the bearings—or yield of the bearings—for in so far as gravity affects the results it is mainly instrumental in raising the speed at which a true whirl is possible, as shown above.

In order to take into account clearance the values of W, y, &c., may be re-tabulated as follows:—

W	y	β*	$y + \beta$	$W y$	$W (y + \beta)^2$
2·3	1·3	0·022in.	1·97	3·00	8·93
5·67	2·05	0·022in.	2·72	11·62	41·96
265·8	2·28	0·022in.	2·95	606·02	2313·00
				620·64	2363·89

* Note that β must be divided by 0.03281 to put it on the same scale as y.

$$\therefore N = \frac{30}{\pi}\sqrt{\frac{386.4 \times 620.64}{0.03281 \times 2363.9}} = 531.1 \text{ revolutions}$$

per minute.

On actually running the shaft the horizontal disturbance commenced at about 500 revolutions per minute. There is reason, however, for believing that this very low speed was due to the yield of the bearings in a horizontal direction; the hammer blows along the line X X—Fig. 3—have a considerable leverage over the bases of the supports, whereas the forces along the line Y Y have no such leverage.

The vibrations in a vertical direction commenced and finished at speeds which depended upon whether the speed of rotation was being increased or diminished. On being increased they commenced at 650 revolutions per minute, and ceased at 680 revolutions per minute. On coming down they commenced at 650 revolutions per minute and ceased at 570 revolutions per minute. The maximum disturbance in a vertical direction as indicated by the pointers moving over the scale P—see Fig. 4—occurred on lowering the speed down to 580 revolutions per minute. The maximum horizontal vibration occurred at 511 revolutions per minute. There appeared to be no true whirl of the shaft, but as the speed was varied a vibration in one direction gradually changed into a vibration in the perpendicular direction.

On the face of them these results may appear to support the above theory but indifferently; on examination, however, the seeming discrepancy disappears. It is plain that 570 revolutions per minute is the lowest speed at which the vertical forces can maintain—not originate—a rhythmic lifting of the shaft through the clearance distance; that when a disturbance has once been set up it is continued to speeds far beyond those which can be established when the speed variation is in the opposite direction. There is no true whirl because the maximum vertical does not occur with the maximum horizontal disturbance.

The accuracy of the theory, however, is less the concern of the writer than the true exhibition of those factors which render the problem much more complex than those people think who expect their mathematics completely to solve it. The usual mathematical solution gives one the impression that there are certain speeds at which the shaft is in a state of instability so highly sensitive that any slight lateral disturbance would cause a catastrophe. This hypersensitive state exists only in the mind of the mathematicians. As shown above there is a certain range of speeds over which the shaft is most sensitive to out-of-balance force, but by reducing the out-of-balance force sufficiently it is possible to run the shaft quite safely at any speed.

It will be noticed that the total range of speed (680 − 570 = 110 revolutions per minute) over which vertical vibrations occurred is about 17 per cent. of the mean speed as compared with 2.8 per cent. for the case of no bearing clearance, and that the top speed approximates to the whirling speed with no clearance; the deflection of the shaft being then great enough to make the clearance comparatively small. With better balance the disturbance—vertical or horizontal—could hardly be detected even with a measuring-lever ratio of 10 to 1.

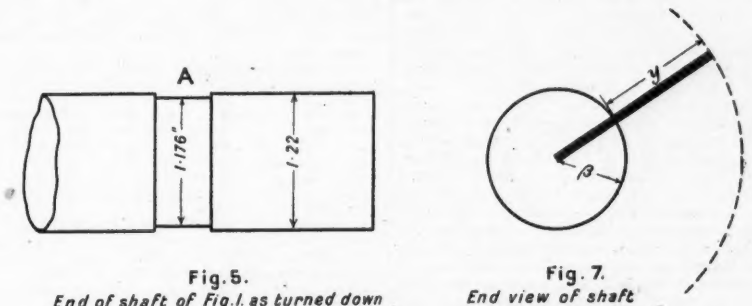


Fig. 5. *End of shaft of Fig. 1. as turned down at the sections of support A-A*

Fig. 7. *End view of shaft showing clearance β.*

Fig. 6. *Illustrating the influence of the radial clearance β on the radius of whirl.*

"THE ENGINEER" SWAIN Sc.

WRITING from the Dominion Observatory, Ottawa, to the editor of *Nature*, M. Otto Klotz states that in making some computations last March about the occurrence of new moon, an error of statement was discovered in the ninth edition of the "Encyclopædia Britannica" under "Calendar," vol. iv., page 594, and repeated in the eleventh edition, vol. iv., page 993; it is also given in Barlow and Bryan's "Mathematical Astronomy," page 215. The erroneous statement is that new moon occurred on January 1st, in 1 B.C. According to M. Klotz, new moon in January, 1 B.C., occurred on January 25th, 12 h. 26 m. Jerusalem Mean Civil Time.

NEW FRENCH INDUSTRIES.

THAT France, in spite of the handicaps inflicted on her by the war, is giving earnest attention to the question of replacing goods of enemy origin by products of her own manufacture, is evidenced by an exhibition of representative manufacturers which was organised by the French *Société d'Encouragement pour l'Industrie Nationale*, and held at its headquarters in June last. According to the *Bulletin* of the Society (July-August number) 71 firms took part in the exhibition. The exhibits comprised :—(1) Products manufactured in France since the beginning of the war, which previously were obtained from abroad ; (2) products which before the war were manufactured principally in the regions now in enemy occupation.

Exhibits of chemical glass and quartz-ware manufactures were specially prominent. One or two firms in France have for some time experimented with a view to obtaining high resistance glasses of the Jena type, and the exhibition showed them to have been successful. Shown on the various stands were chemical and bacteriological glass-ware of all kinds, Dewar bottles, gas determination apparatus, clinical thermometers, &c. Of special interest was a Coolidge tube, which one manufacturer has taken up enthusiastically, and the use of which, as M. Féry has pointed out, is now assuming importance in connection with radiographic investigations on metals. Very few firms have been able successfully to manufacture fused quartz tubes on a commercial scale, but France has taken up the question seriously, as was shown by an exhibit of two quartz lamps. Included in the exhibition were various earthenware products used in the manufacture of acids, of which products Germany supplied one-third before the war.

Chemistry was well represented with numerous exhibits of organic compounds, including important coal-tar derivatives necessary for the manufacture of explosives, synthetic nitric acids and nitrates, &c. Progress has been made in the manufacture of rare earth compounds, which in peace time came almost exclusively from Germany, while cerium, ferro-cerium, and magnesium—manufactured for the first time in France—have passed the experimental stage.

In engineering the exhibits did not assume the same importance ; doubtless on account of the high pressure at which all firms are at present working. The machine tools and small tools exhibited showed, however, that France is capable of developing in this direction. Germany held a monopoly in France prior to the war for small electric motors, but one or two French firms are now turning their attention to this branch of manufacture, as well as to the construction of magnetos.

THE MACHINERY TRADE AFTER THE WAR.

NOTWITHSTANDING the release of a large number of the factories now engaged upon war munitions as soon as peace has been proclaimed, there is some doubt about the ability to replace in anything like sufficient quantity or time the immense amount of machinery that will be required. During the last two years it has been difficult to obtain from European manufacturers new machinery of any kind, while, since the United States came into the conflict, the same lack of ability to fulfil South American orders has been manifest from this direction. Important repairs have had to be postponed, and an enormous quantity of existing machinery will have to be "scrapped" and replaced by entirely new installations. A leaf might well be taken, by our larger manufacturers of machinery and equipment, out of the book of our keen rivals, the North Americans, who, in order to grapple with the unprecedented demand after the war, have already formed among themselves what is known as the "Allied Machinery Construction Corporation," which represents a group of leading, but non-competing, manufacturers of construction machinery, and who, taken together, produce all of the main types of such equipment. The group, however, excludes concrete mixing and distributing plants, steam and other power shovels and excavating machines, trench and ditch-digging machines, grab buckets, hoisting engines, light railway lines, light locomotives, and cars of all types, and a great variety of similar special equipment. We have something of the kind already in the machine tool trade, and further developments would undoubtedly prove beneficial.

From the inquiries that have been pouring into the different factories for many months past, and which can only be satisfied in full when normal conditions are again restored, it would appear that the greatest demand for South America will be in the following lines :—Machine tools and sugar-cane machinery, all kinds of labour-saving construction machinery. agricultural machinery and implements. It is thought that a few smart and enterprising travellers, representing the great manufacturers of the specialities mentioned, could do a very prosperous business in both South and Central America if a move in combination were made at the earliest moment. One traveller, for instance, might act as the agent of a dozen, or even more, non-competing firms, thus minimising the expenses and securing co-operation for some considerable time to come in the shipping difficulties which will have to be faced and overcome even after the war is over.

EDUCATIONAL INTELLIGENCE.

COURSES of lectures on railway subjects will be given at the London School of Economics and Political Science (University of London), Clare Market, Portugal-street, Kingsway, in the coming session, opening with an inaugural discourse on the "Science of Transportation," by Sir George Gibb, on October 10th, at 6.30 p.m. This lecture will be open to the public, without fee. The courses, of which full particulars can be obtained from the School Calendar, will be given by Professor Sargent, "The Geography of the Railways, Waterways, and Seaports of Great Britain ; " by Mr. Burtt, "The Railway System as a Wealth-creating Machine," "Elementary Problems in Transportation," "The Principal Factors in Railway Operating," "The Basis of Railway Rates and Charges "; and by Mr. Disney, "The Law of Carriage by Railway." Special lectures will also be given by Mr. Stephenson and Mr. Burtt.

JAPAN AND THE WAR.

UNTIL the present time there has been a great deal of secrecy concerning the part which Japan has taken in the war, and there has been a disposition in some quarters to believe that our Eastern ally has not rendered her European allies the full co-operation which might have been expected. There are good grounds for asserting that any such criticism is based on a misunderstanding of the facts. The entry of America into the alliance has had the effect of modifying the reserve which has been maintained as to many phases of the operations in progress, and a statement as to the actual part taken by Japan has been made coincident by the arrival in Washington of the Japanese Mission to the United States. It is the fact, however, that military reasons have made it necessary to refrain from making public until now the work of the Japanese Navy, and it will, doubtless, be a surprise to many to learn the extensive naval operations which have been undertaken by Japan. At the outset of war Japanese warships operated between the Yellow Sea and the northern part of the Eastern Sea, while other ships took up their station outside Tsing-Tau. In close co-operation with the British Fleet, Japanese warships patrolled the Indian Ocean and the Bay of Bengal, and at times Japanese cruisers, notably in connection with the hunt for the Emden, operated in the Northern Pacific. When troops from the Overseas Dominions commenced to flow into the European battlefield, Japanese destroyers and cruisers undertook to patrol the Pacific trade routes, leaving British warships free to escort troopships from Australia and New Zealand.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"PRACTICE IN BRIDGE AND GIRDER YARDS FROM A THEORETICAL STANDPOINT."

SIR,—I am sorry that, owing to pressure of work, I have not been able to reply earlier to Mr. H. R. White's letter in reference to above, which appeared in your issue of the 24th August. I was aware, when the article was first written, that there were many contentious questions raised, and that discussion and criticism might be expected, and would be welcomed.

I hardly thought, however, that the details in such a sketch as Fig. 2 would come into this category. The intention was to show types of holding down bolts, not to give an exact sketch of an ideal base—the figure was copied by a draughtsman from hand sketches only—but Mr. White's criticism is quite justified, and the weakness he points out is one to be guarded against.

As to the design of continuous girders, the correspondence column scarcely allows space enough for such an important subject being discussed as it should be. But, after all, the suggestion made in connection with Fig. 14 is an application which is of universal practice in theatre work—and the supporting girders are part of the elastic structure there, too. Similarly purlins and roof girders of quite large span are designed and built as continuous in many existing large structures, and the supports—the main truss frames—are again part of the elastic structure.

It is suggested by Mr. White that the secondary stresses induced in railway girders, &c., can best be taken care of by the present method of detailing, and by calculating and providing for such stresses ; but, as it would seem, by still considering the girders as freely supported at ends. I agree with him entirely in his study of proportions, and his endeavour to adopt the type which will give the least secondary stresses. But this does not remove the trouble ; if the detailing is "as at present," then no amount of calculating can make them other than fixed ended girders.

If a designer adopts a free ended girder because he can better calculate the stresses, and because the proportion of secondary stresses in same is less than in another type, he is altogether right ; but if he calls a fixed ended girder, freely supported, simply for ease in calculation, he is hopelessly wrong. One would like to see a detail drawn of a connection of a stringer which would eliminate the intense stress in the rivet heads shown by my calculations in reference to Fig. 13. I know that in the majority of cases of bridges here and abroad the usual method is to ignore such stress.

I quite agree with all that is said about "grounding in first principles," and the educational and training side of the question. However, the article I wrote could hardly have dealt with such questions without departing from the subject matter. Personally, I feel that a man cannot be a good engineer unless he is a good practical mathematician ; and we have so many good engineers in this old country, I did not think that they as a body "feared the calculus." Surely every prospective engineer is studying or has studied the differential and integral calculus, and looks upon X^n as an old friend, not unlike Prop. V. Euclid (Book I.) ; somewhat difficult and elusive at first, but a veritable bridge to everything of value beyond. Not only in regard to study, but in training and indentures of prospective structural engineers, a great deal needs to be done if we are to hold our own. I think steps are being taken to bring the colleges and workshops more into line in regard to a co-ordination of effort, and this should prove a wonderful help and advance in structural engineering.

G. KENWORTHY, Assoc. M. Inst. C.E.

Glasgow, September 12th.

FUEL ALCOHOL.

SIR,—The Advisory Council of Science and Industry of the Commonwealth of Australia, with whom this Committee is co-operating, is desirous of obtaining an efficient alcohol engine to exhibit at work at agricultural shows and other exhibitions in Australia, with the object of exciting public interest in the use of alcohol as a fuel. It is recognised that such engines may not be readily obtainable at the present time, but I should be glad to receive, for transmission to Australia, any available information as regards the cost of efficient alcohol engines, and the probable date of delivery. For purposes of demonstration a small stationary engine of 5 to 10 horse-power would be preferred.

It is suggested as an alternative that if it is impossible to obtain delivery of a suitable engine at a comparatively early date, a complete set of plans might be purchased, with a view to the engine being constructed in Australia. In either case, it is desirable that any information sent to me should include particulars as regards patents by which the engines advocated are protected, and the arrangements which would have to be made in respect of royalty, &c., if it were decided to build now or subsequently in Australia. It is probable that the Advisory Council of Science and Industry of Australia will, on receipt of the required information and recommendations, order an engine—or plans if no engine be available—by cablegram.

I should be glad to hear promptly from any of your readers who may be interested in these proposals.

HORACE WYATT,
Secretary, The Alcohol Motor Fuel Committee.
The Imperial Motor Transport Council,
39, St. James's-street, London, S.W. 1.
September 14th.

SOLID FUEL FOR STEAM CARS.

SIR,—Considering the cost and difficulty of obtaining either petrol or paraffin, cannot some British engineer design a steam generator to burn small coke or anthracite coal ?

Having owned four steam cars, and inspected others, it appears to me that it should be possible to work a simple generator with solid fuel, making the generator also the fuel hopper, and confining combustion to the base, regulating the fire entirely by forced draught. I suggest a double skinned boiler with tubular fore grate, so that the wet steam would be superheated. The forced draught would maintain a hot fire. The ashes box would, of course, be air-tight. The exhaust gases would escape below the car and could be taken to the rear if necessary.

Seeing thet there are steam omnibuses and motor lorries running successfully on coke, requiring only one driver, there should be room for a light chassis working on the same system. The cost works out equivalent to petrol at fourpence a gallon. Or an alternative would be to have a generator entirely tubular, like the White, but cone-shaped, so that the fuel would always feed itself to the combustion base chamber. Think of the thousands of light steam commercial cars that would be ordered if coke could be used.

C. D. LENG.

September 19th.

AN EARLY STEAMBOAT.

SIR,—In Mr. Walsh's interesting letter, published in your issue of yesterday's date, *re* "An Early Steamboat," he is evidently under the impression that when I referred to Trevithick as "the pioneer of this branch of engineering" I regarded him as the inventor of the steamboat. Of course, even those with the least knowledge of the history of steam-propelled vessels know this was not so.

Robert Scott Burn, in his "History of the Steam Engine," mentions an invention for the propulsion of vessels by one Blasco de Garay, a sea captain, when :—"Commissioners were appointed by the Emperor Charles the Fifth to test the invention at Barcelona, on the 17th June, 1543 ; and the result was that a ship of 200 tons burden was propelled by the machine at a rate of three miles an hour. The moving force was obtained from a boiler containing water, liable, as was said, to explosion ; and paddle wheels were the propelling power. Strange as it may appear, no further result was obtained from this trial, and the invention was lost sight of." Since that date many have had "ideas," some of which have, as Mr. Walsh has pointed out, taken practical form.

I should like to know if Mr. Evans' "Lighter" of 1804 was propelled by high-pressure steam. Mr. Walsh's interesting mention of "Messrs. Trevithick and Vivian's high-pressure engine, patented 1802," confirms my opinion that the first instance recorded of a vessel propelled by high-pressure steam and used in the transportation of merchandise is that recorded by Francis Trevithick.

ARTHUR LEE.

Eastgate, September 15th.

PLYMOUTH AS A COMMERCIAL PORT.

SIR,—Having read with interest the article in your issue of the 14th inst., relating to the development of the Port of Plymouth, perhaps it would not be out of place at the present moment to remind you of the schemes which were put forward by the late Mr. R. H. Ellacott, of Plymouth. His schemes covered an idea to develop the western entrance to the Sound, and alternatively, owing to its not being accepted, a proposal was put forward by him which covered the Wembury side.

My object in bringing this forward—through your courtesy—is that possibly some of your readers who are interested would find useful information by referring back to his proposals.

R. E. ELLACOTT.

Sheffield, September 17th.

ORGAN BLOWING.

SIR,—I should be glad if any of your readers could give me any information on organ blowing by an ordinary town gas engine. The instrument is a two manual organ—thirteen stops—with pedals and usual couplers. Information is desired as to a suitable type and size of engine, and as to the best methods of silencing, &c.

CHAS. M. PENMAN.

Lasswade, September 14th.

COUNTY OF LONDON ENGINEER VOLUNTEERS (FIELD COMPANIES).

Headquarters, Balderton-street, Oxford-street, W. 1.

ORDERS

For the week by Lieut.-Col. C. B. Clay, V.D., Commanding.

Officer for the Week.—Sec.-Lieut. C. E. Campbell.

Next for Duty.—

Monday, September 24th.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class, 6.30. Recruits' Drill, 6.30.

Tuesday, September 25th.—Physical Drill and Bayonet Fighting.

Wednesday, September 26th.—Drill and Elementary Bridge Construction for No. 1 Company, Right Half Company.

Thursday, September 27th.—Drill and Elementary Bridge Construction for No. 2 Company, Right Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, September 28th.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.

Saturday, September 29th.—Commandant's Parade for Route March and Drill. Parade at headquarters, 2.45 p.m. Uniform. "A" and "B" N.C.O.s and men are reminded that one route march a month is compulsory. Recruits' Drill, 2.30.

Musketry.—All N.C.Os. and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify, in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be obtained at headquarters, and every enrolled man must obtain one without delay ; at the same time, all old red armlets—now obsolete—must be returned.

Note.—Unless otherwise indicated, all drills will take place at headquarters.

By order,
MACLEOD YEARSLEY,
Captain and Adjutant.

September 22nd, 1917.

RAILWAY MATTERS.

As a result of the difficulty in getting the materials for rails, telegraphs and signals, it has been found impossible to complete the new underground railway in Copenhagen.

IN 1903 the average freight train on the eastern railways of the United States had a load of 301 tons; in 1910 it was 478 tons; by 1914 it had increased to 576, and in 1916 it was 675 tons.

THE American Railway Association has abandoned the phrase "car shortage" for the briefer, but more exact term, "unfilled car requisitions." These designations apply to requests for cars that cannot be met, whilst "car surplus" is the number of wagons standing idle.

THE London "Safety First" Council has arranged a Freedom from Accidents Competition for drivers, with a view to reducing the number of accidents which occur annually in the Greater London area. The competition will commence on the 1st prox., and close on September 30th of next year.

ACCORDING to a report issued by the United States Geological Survey, the American railroads in 1916 used 135,000,000 tons of bituminous and 6,735,000 tons of anthracite coal. This is an increase of 14,000,000 tons or 11½ per cent. in bituminous, and of 535,000 tons or 8¼ per cent. in anthracite.

IT was stated during the hearing recently at a Metropolitan Police-court of a case of theft of goods on the railway, that during the last two years robberies from railway companies had increased to an enormous extent, and that from the St. Pancras depôt, the Midland Railway Company had made good losses amounting to £5300.

ON the resignation of Mr. W. B. Leane, the chief engineer of the Central Argentine Railway, on November 22nd, 1916, Mr. Ralph Kirby was appointed acting chief engineer and on July 1st last he was confirmed in this appointment. Mr. Kirby is the son of Mr. C. A. Kirby, the late district engineer for the Great Northern Railway at Boston, and was, from May, 1911, until his present appointment, chief construction assistant to the Central Argentine chief engineer.

MENTION was made in this column recently of the efforts made by an American railway company to economise in the destruction of live stock killed when trespassing on the line. Action is now to be taken by all the companies, as under the law the railways are responsible. In the year ended June 30th, 1917, the Southern Railway Company paid 200,000 dols. in compensation for cattle so killed, whilst the Baltimore and Ohio paid 12,786 dols.

ACCORDING to a bulletin issued by the National City Bank of New York, the locomotives exported from the United States in the year ended June 30th, 1917, were estimated to number 1290, and be of a value of 16,037,000 dols., as compared with 799 of a value of 12,665,000 dols. in 1916, and 228 of a value of 2,115,000 dols. in 1915. Of steel rails there were, in 1917, 611,000 tons worth 26,632,000 dols.; in 1916, 540,000 tons of a value of 17,687,000 dols., and in 1915, 159,000 tons, worth 4,537,000 dols. In railway track material exported in 1917, the value was 8,164,000 dols.; in 1916, 5,261,000 dols., and in 1915, 2,407,000 dols.

SOME further proof of the largely increased traffic that the Furness Railway Company has to carry is to be seen in the fact that that company now runs every week-day four trains from Barrow to Carlisle and back, in addition to two conditional trains, *i.e.*, which run if required, and two from Barrow to Tebay and back. To balance the running over foreign lines the foreign companies work trains as follows:—The London and North-Western has two between Tebay and Millom and back, and two between Tebay and Barrow and back, and the Maryport and Carlisle has one each way between Carlisle and Barrow. In addition, the North-Eastern has two between Carlisle and Millom and back.

IT is very gratifying to find that whilst the ratio of expenditure to receipts on the Italian State Railways was 81.26 per cent. in the year 1914–15, it fell to 76.78 per cent. for the year 1915–16, although the coal bill for the latter year was 217,900,000 lire, or 28 per cent. of the receipts, as compared with 107,600,000 lire or 18.5 per cent. in 1914–15. In 1913–14 the coal bill was 76,000,000 lire or 12.8 per cent. Traffic receipts in 1915–16, as against 1914–15, showed an increase of 229,351,000 lire, which were earned with an increase of only 178,960,000 lire. This reduced expenditure, despite the higher cost of coal, has been, in part, obtained by increased loading. Whilst train mileage increased by 5.9 per cent. and locomotive mileage by 9.7 per cent., the kilometric tonnage increased 21.5 per cent.

ON Saturday morning last, early, some soldiers were being entrained at a military camp in North Yorkshire into some carriages belonging to the North-Eastern Railway Company. The railway is on private property and is not used for the public conveyance of passengers. It is worked by the military, to whom the locomotives belonged, but the carriages, at least those on this occasion, were provided by the North-Eastern, whose line was joined about five miles from the camp. It would appear that on the previous day there had been some trouble with the Westinghouse brake with which the coaches were equipped, and therefore the lance-corporal who dealt with the train secured the carriages by fastening down four hand brakes. Whether these were interfered with in any way by some of the men when they entered the train is not known, but it would seem that as soon as the weight of the men and the spring set up by their entry got into effect on the vehicles the latter began to move—the engine not having then been attached—and soon got up speed owing to the sharp fall in the line. About three miles from the camp there is a sharp curve, and at this point the last nine of the ten carriages on the train were derailed. The leading coach continued on its way and at the junction came into collision with some buffer stops. Three soldiers were killed and one died subsequently. The coroner held his inquiry on Monday last, when the jury returned a verdict of "Accidental death."

NOTES AND MEMORANDA.

FIVE years ago the United States annual output of farm tractors was 1000 machines. Last year it is said to have passed the 70,000 mark.

THE United States super-dreadnought Tennessee will be driven by four alternating-current motors, one to each propeller shaft, supplied by current at 3400 volts from two 13,500 horse-power turbo-generators. The motors will be wound for both 36 poles and 24 poles, operating on the former as squirrel-cage machines and on the latter as wound-rotor machines.

AN alloy that has proved very satisfactory for ships' propellers is turbadium bronze. This material has a tensile strength of 35-42 tons with an elongation of 14-20 per cent. on a 2in. test piece, and it is not appreciably corroded by sea-water. According to the *Chemical News*, its composition is, approximately, copper, 48 per cent.; zinc, 46, 45; tin, 0.5; lead, 0.1; iron, 1; aluminium, 0.2; manganese, 1.75; nickel, 2.

STEADY progress is being made in the United States of America towards the adoption of what has been agreed as standard voltages of electric supply—viz., 110, 115, and 120 volts. In June last the *Electrical World* reports that 66 per cent. of the stations in the United States were operating at a standard voltage compared with 61 per cent. in March, 1916, but in Ohio the figures were 78 per cent. and 57 per cent. respectively. 45.6 per cent. of the stations in Ohio have adopted 110 volts, 30.2 per cent., 115, and 6.5 per cent. at 112 volts, while 4.6 per cent. operate at 220 volts, and only 2.0 per cent. at 120 volts.

AN American firm has developed an optical pyrometer for works use in which the luminous radiation from a heated body is balanced against that from a standardised light source. The instrument is designed for measuring temperatures from approximately 1100 deg. Fah. to the highest known, a screen being employed to reduce the light from bodies having temperatures in excess of 2500 deg. The instrument is portable, weighing but a few ounces, and can be sighted, it is emphasised, as easily as an opera glass. The case containing the storage battery, rheostat, and milliammeter, employed in connection with the pyrometer, weighs approximately 10 lb., and is designed to be slung around the neck of the operator.

THE last annual report of Mount Wilson Observatory contains the interesting news that the mirror of the 100in. reflector—much the largest telescope in the world—is now completed and silvered. Its clear aperture is actually almost 101in.; the thickness at the edge is 12.75in.; and the mirror weighs nearly 9000 lb. At the centre, where the difference is greatest, the depth of the finished paraboloid differs from that of the nearest spherical surface—to which the glass was brought in preparation for parabolising—by almost exactly 0.001in. In silvering, 35 gallons of distilled water were required to fill the concavity, and to this were added 9 gallons of dilute silver solution and 9 gallons of dilute reducing solution. The deposition of the silver required 15 minutes.

THE output of petroleum in Burma during the year ended December 31st, 1916, according to the returns relating to the production and distribution of minerals in Burma, is the highest yet obtained, exceeding the record production of the preceding year by nearly 9.5 million gallons. The yield of crude oil from the petroleum fields of the province began steadily to improve in 1911, and within the short space of two years the output reached a record. There was a decline in production in 1914 on account of the disorganisation of trade in the first few months after the outbreak of war, and the presence of enemy commerce raiders in the Bay on the trade routes. The demand for oil fuel by the Admiralty served as an impetus to an increased production and the output in 1915 increased by 27.6 million gallons.

ZINC is often used in the so-called "gun-metals" employed in marine engineering in considerably greater proportions than the 2 per cent. specified in the Admiralty mixture, according to Mr. J. T. Milton. It is sometimes said that the greater proportions are used because zinc is cheaper than either copper or tin. Lead is also often added, but not always with the view of making a cheaper mixture. The addition of lead renders the metal less tough, and therefore more easy to machine, and for this reason it is, to say the least, not objected to by the machinist. It is also claimed for certain admixtures of lead that they render the metal more suitable for bearing purposes, by reducing the friction under heavy loads, and, especially in America, alloys containing considerable quantities of lead are used for bearings in heavy machinery.

IN an article in the *Iron Age*, on a special process for forging shells at Curtis Plant, St. Louis, the writer states that there are three critical zones of temperature which have to be considered in normalising a shell forging, namely, a lower zone about 600 deg. Fah., below which the forgings must cool after forging and before normalising; a middle zone of about 1450 deg. Fah., at which the grain structure of the steel refines if the steel is held at that temperature; and a third zone of about 1650 deg., above which the grain structures enlarge and carbon conditions change. The exact temperatures of these three heat zones and the time which the steel must be subject to these temperatures vary with the analysis of the steel, and the company has found that the time and temperature factors for bar steel differ from the similar factor for cast steel of identical analysis.

THE general methods of signalling on telephone trunk lines in England are by means of an alternating current at approximately 17 periods per second or by means of the "permanent current" system. In the case of the former, the signalling is not automatic, and some delay to the service is therefore caused, especially in clearing the trunk when a conversation has finished. The "permanent current" system is automatic in its action and depends upon the connection of a battery to the line at each end in such a way that the polarity is reversed or the battery disconnected upon inserting the peg in the line jack. To obviate the drawback to the latter system a method has been devised by Messrs. J. G. Hill and C. Robinson, in the Research Department at the Engineer-in-Chief's office at the G.P.O., which is described in the *Post Office Electrical Engineers' Journal* for July.

MISCELLANEA.

FOR fire-box steel for both locomotive and stationary service the manganese requirement under specifications of the American Society for Testing Materials has been put tentatively at 0.30 to 0.60 per cent.

ACCORDING to the "Journal" of the Royal Society of Arts, the cement industry in Japan has made rapid strides since the beginning of the war. The production has risen from 3,741,000 barrels in 1913 to 3,943,000 barrels in 1915, and the output during 1916 is understood to have been still greater. Five years ago there were practically no exports, but in 1915 upwards of 600,000 barrels were exported, and a considerable trade is being built up in India and in the South Seas.

WE learn from the *Iron Age* that the Engineers' Club of Philadelphia is waging a campaign to raise £15,000 for a new club-house. The plan of the board of directors is to purchase property adjoining the present club-house, and connect the properties to make a commodious building adequate for the present membership, which numbers more than 2000. We understand that the only purely engineers' club in this country, namely, the Manchester Engineers', is also considering the enlargement of its premises to provide better accommodation for its 800 members.

BY prohibiting the further installation of electric furnaces except under permit, the Ministry of Munitions is threatening to bring to a standstill, or nearly so, the development of electric steel making, which has lately made such astonishing progress in this country, and thereby to injure seriously the future welfare of the British steel industry, says the *Ironmonger*. The leading authorities are agreed that electric steel is destined to play a part of enormous importance, and a country which fails to prepare for the new conditions must therefore be grievously handicapped in competition with more far-seeing rivals.

THE electric melting of brass has been under investigation for several years at Cornell University through a co-operative arrangement between the university and the Bureau of Mines. Long series of experiments have indicated that the use of a suitable electric furnace might materially reduce the metal losses and avoid the use of crucibles. According to the *Iron Age*, the Bureau of Mines is now testing an electric furnace built on the design worked out in the laboratory tests. It is of commercial size, installed in a brass foundry, and is being tested with special attention to its suitability for such brasses as are used for cartridges and shrapnel cases.

THE control which the Germans obtained before the war of the only available supplies of monazite sands, the raw material of gas-mantle manufacture, is now only too well known. The hopes that the Brazilian monopoly would be broken by the discovery of deposits in Travancore, India, were dispelled later by the discovery that the Germans had obtained financial control of the British company which was formed to work them. Now the German influence has been eliminated, and further deposits are being worked, says the *Ironmonger*. An important new development, however, is the discovery of deposits of monazite sands in Ceylon which, on investigation at the Imperial Institute, have given such good results that the Ceylon Government has made arrangements to work them. This is one outcome of the mineral survey of the Empire.

MECHANICAL cultivation seems to be making headway in India. We learn from *Indian Engineering* that ten power plants for agricultural purposes were erected in the Bombay Presidency during the years 1915-16. Instruction in engine driving is being given at the workshop of the College Farm of the Department of Agriculture, and everything possible is being done to overcome the initial difficulties which must occur when inexperienced people take to the use of machinery. Each of the steam ploughs owned by the department worked at a small profit after paying all charges, including depreciation and interest. In Gujarat during the year 1203 acres of rough, virgin land were broken up to a depth of 1ft., and the large clods harrowed down at a cost of 16 rupees per acre. In the Dharwar district 554 acres of grass-bound land were broken up to a depth of 16in., at a cost of 25 rupees per acre, and by way of extending the short working season a further area of 146 acres was subjected to shallow ploughing.

THE British Trade Commissioner in Australia, after visiting the Broken Hill steelworks, Newcastle, N.S.W., reports that large quantities of rails have been turned out, principally for the Government railway between Port Augusta and Kalgoorlie. The demand for rails has been so great that the company has found it impossible to carry out its intention of rolling plates and sheets. Channel sections are being rolled to the order of the New South Wales Government. Before the war practically all such sections were imported from Europe. The company, it is stated, can roll 4ft. plate for its own use, but is not in a position to roll 5ft. plate, the most suitable size for shipbuilding. It is thought, however, that it may be possible to utilise 4ft. plate for shipbuilding, and if this can be done one of the hindrances to the development of the shipbuilding industry in the Commonwealth will be overcome. Other prospective developments in connection with the steelworks include wire drawing and the manufacture of wire nails.

THE Victorian State Government has decided to proceed with a scheme for the storage of wheat. The proposed State expenditure on the construction of storage silos in Victoria is estimated at £750,000. Cylindrical silos are to be constructed of cement in a number of districts, and these silos are to be erected and disposed in such a manner that, at a later period, they can be incorporated in a bulk-handling scheme. The construction of the storages is to be begun as soon as possible, as practically the whole of last season's crops is still in the country and provision has to be made for the storage of the 1917-18 crop. The storages are to be fitted with the necessary machinery to turn the wheat so as to keep it in good condition. It is proposed that there shall be about 130 storages in the State and that the terminal points shall be at Williamstown and Geelong. The silos are to provide for the immediate storage of about 10,500,000 bushels, of which nearly 6,000,000 bushels will be in the country districts, and the balance in the terminal silos.

SOME EXAMPLES OF CHAIN-TRACK VEHICLES

(*For description see page* 241)

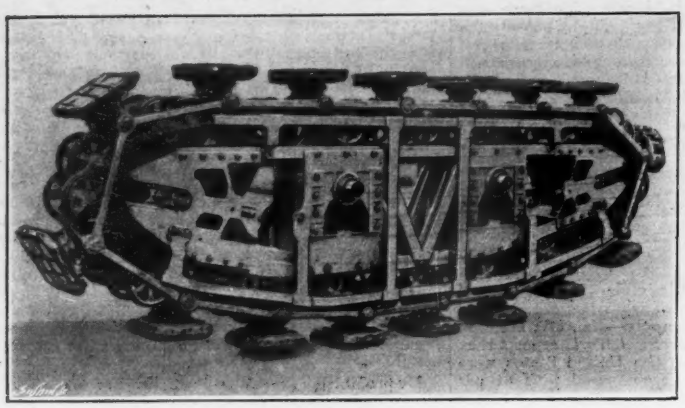


Fig. 78—THE DIPLOCK CHAIN-TRACK, 1911

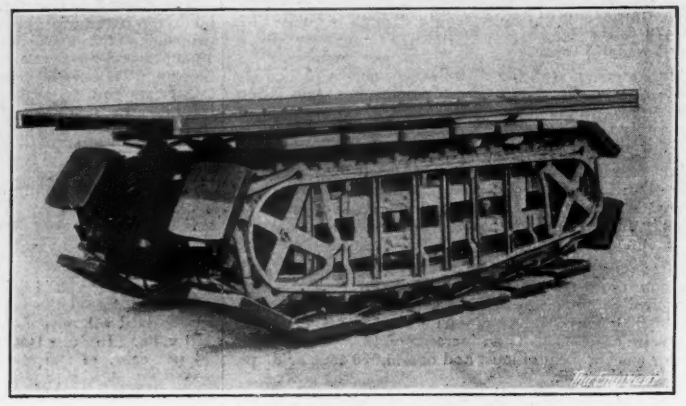


Fig. 79—DIPLOCK CHAIN-TRACK VEHICLE, 1911-12

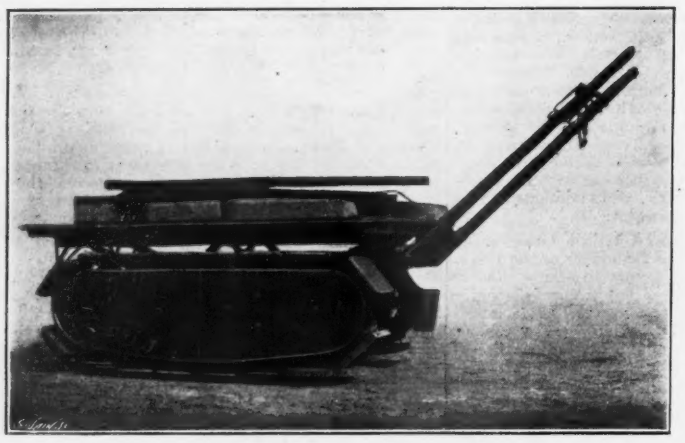


Fig. 80—DIPLOCK CHAIN-TRACK LORRY, 1912

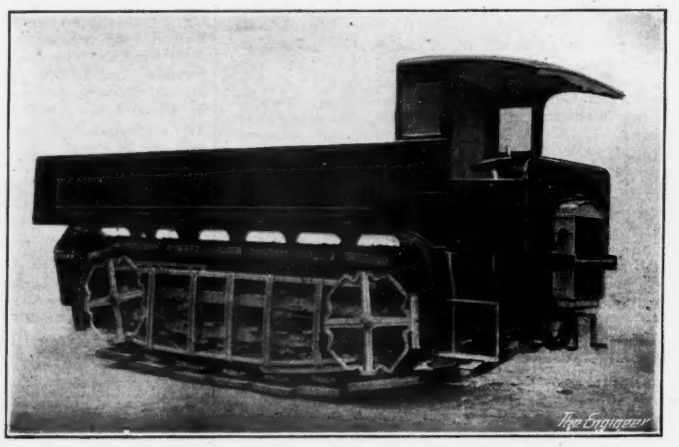
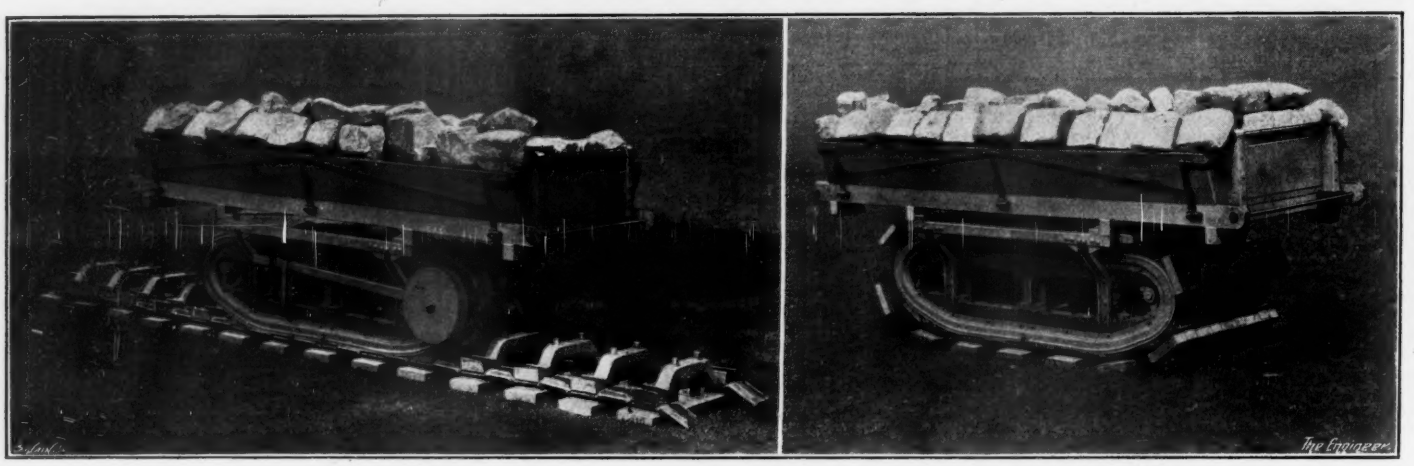


Fig. 81—DIPLOCK CHAIN-TRACK TRACTOR, 1913



Figs. 82 and 83—THE DIPLOCK ONE-TON CHAIN-TRACK WAGON—PRESENT DAY

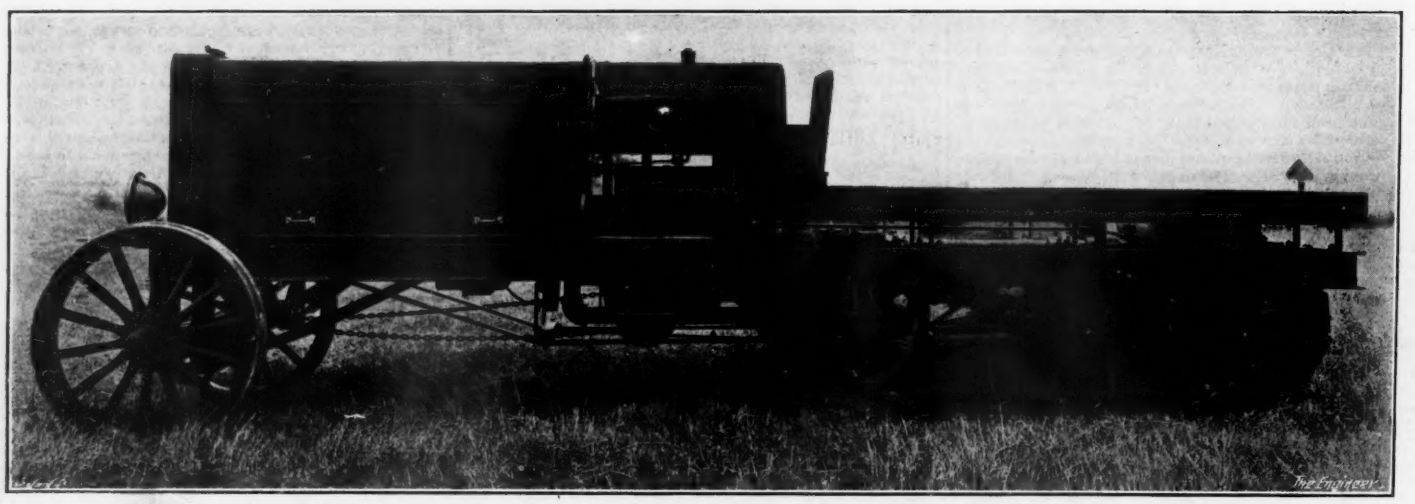


Fig. 84—THE LOMBARD AGRICULTURAL CHAIN-TRACK PETROL TRACTOR—PRESENT DAY

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STRAITS SETTLEMENTS.—KELLY AND WALSH, LIMITED, Singapore.
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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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TWO-PAGE SUPPLEMENT.—AN ENGLISH AEROPLANE FACTORY

TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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THE ENGINEER.

SEPTEMBER 21, 1917.

The Controlled Owner.

WE sometimes find ourselves wondering if the general public is aware how great is its debt to the manufacturer who is known in official circles as the "controlled owner"? The name almost carries with it its own definition, and it is hardly necessary to say that the "controlled owner" is a company that carries on the manufacture of munitions of war under the control, but not under the direction, of the Ministry of Munitions. The National Factories are managed by men in the Government pay; they are exactly what their name implies—workshops belonging to the State, in just the same way that the Royal Dockyards belong to it. The controlled factories differ from them in this respect, that they are run by their directorates for the benefit of shareholders. In one way or another, there are now something like five thousand companies of this kind, and whilst all are not as equally deserving of our praise as some, we do not hesitate for one moment to say that it is the controlled owners rather than the National Factories that are the very backbone of the munitions-making industry.

It may be hoped that before the war is long over the history of many of these establishments will be told in detail. They have much to endure, and if it were not for the ungrudging patriotism of many a controlled owner who has suffered for it things that nothing else could have inspired him to suffer, the country would have been in difficulties for its supply of shells and explosives, aeroplanes, guns and tanks long ago. The public, basing its opinion on a few facts that it has picked up here and there, and has been rarely in a position to verify, is prone to look upon the controlled owner as a profiteer who has made, or is endeavouring to make, a fortune out of munitions, and who would look upon the conclusion of the war with little favour. Few people know, however, the enormous sums of money that these firms have invested in the creation or enlargement of factories, money which, in many cases, there are no equivalent assets to meet. The firms have relied upon the Government to make them grants to write off against their outlay, and there is a special committee—at one time attached to the Ministry, but now, we believe, reporting direct to the Board of Inland Revenue, and so to the Treasury—whose duty it is to investigate by personal inquiry the country's financial indebtedness to the controlled owner. The problems the members of this committee have to face are not easy. They see that a firm has enlarged its shops, increased its plant, and expended a huge capital. In some cases they may feel justified in saying that the whole outlay is for war purposes, and that there is little or no probability that, when peace returns, the enlarged factory will be any use for the arts of peace. In such a case they might, conceivably, recommend the Treasury to meet the whole capital outlay. The circumstances are, however, rarely so simple. The committee finds, generally, that it has to decide what proportion of the capital outlay may justly be regarded as of permanent value to the controlled owner. As an example of cases of the first kind we may, whilst avoiding specific examples, instance a manufacturer in another line of business who, at the request of the Ministry, took up the manufacture of explosives or chemicals. The plant will be of little or no use to him after the war, and there will be little or no demand for the product when the country's need for explosives drops back again to its pre-war level. In such circumstances can there be any doubt that the right course is to allow the controlled owner the full value of the capital he has expended? We have put the example of chemicals or explosives because it is obvious at first glance, but many others of a more mechanical description might easily be given, of which drawn tubes may be taken as a single instance. As a more difficult example, let us put the hypothetical case of a controlled owner who, in the ordinary course of business, makes gas engines, but has taken up the manufacture of shell. He has had to build new shops, to get together an enormously enlarged staff and many times his normal quota of workpeople—one firm, for example, employs now over twenty thousand where two thousand were sufficient—to put down a great number of machine tools, and to provide engine power to drive them. What proportion of his outlay may be deemed unprofitable to him in the present, and likely to remain unprofitable to him in the future? What proportion of his plant, worked frequently by girls who are good drivers but bad engineers, will be of more than nominal value after the war? These are the sort of knotty problems that the committee to which we have referred is called upon to solve. At one time there was distinct evidence of an inclination to take much too rosy a view of the controlled owner's prospects, and as a consequence to allow him too little for "writing down," but from what we have heard we gather that of late there is improvement in this respect, and that the country's indebtedness is more honourably acknowledged. We submit, however, that there are cases which were settled in the past which should, in all fairness, be reviewed in the future, and the Association of Controlled Firms might do worse than press for the establishment of a court of appeal at which such cases could be heard. We venture, indeed, to assert that, for the ultimate benefit of the country, it is better to deal generously with the controlled owner than to be mean or parsimonious with him, for he has staked everything to meet the present needs of the country, and the country will unquestionably suffer during the period of revival if he is not in a position to take fortune at the flood.

It is easy to overlook the importance of this question. Those who think about it lightly imagine that the country benefits if a manufacturer is squeezed into accepting a figure lower than is his by right. They close their eyes to the fact that we have not only got to carry the war to a satisfactory conclusion, but that after the war we have got to re-establish our manufacturing industries as rapidly as possible. That cannot be done without capital, and plenty of capital. The controlled owner might have acquired capital had he been allowed to retain a larger portion of his profits, but when first 60 per cent. and then 80 per cent. was taken from him he found himself in the position where he was not making enough to meet the liabilities he had incurred in the development of his works. Unless manufacturers in that position are helped, and helped liberally, many of them will be bankrupt after the war, and the chances of a rapid recovery will be remote. We know, only too well, that there is a certain section of the public that carries its detestation of capital so far that it would not hesitate to perpetrate this injustice, and this worse than injustice, this economic folly, in order to gratify its hate; but we are confident that the great mass of the people are conscious of the value of capital, and if the facts were only put before them would be willing to acknowledge the enormous debt, a debt which can only be measured by those who have studied the question in detail, that the country owes to the controlled owner. We wish we were free at the present moment to put before our readers specific cases, of which we can lay our hands on many, of the incalculable services that controlled firms have rendered the country. There are obvious reasons why that should not be done till the war is over, and we can only ask those who are not in such an advantageous position to judge as we are, to believe that over and over again, in literally hundreds of cases, the welfare of the country has depended upon the energies, upon the open-handedness of the controlled owner who has taken upon his shoulders liabilities that he is totally unable to meet without the liberal assistance of the Government. He has not gambled in futures. In many, in very many cases, there is no obvious future at all. He has put down plant, and he has driven that plant to the utmost because it was wanted, and he has trusted to the country to defray the cost when it knew the circumstances under which it was incurred. On what they have done controlled owners preserve an enforced silence, but when the full tale is known we do not hesitate to say that the country will recognise its indebtedness, and will have no patience with those who desire to squeeze controlled firms for the last farthing. The capital of our manufacturers is an asset which will help us to meet the competition of the world, and put us in a position not before held. Every encouragement should therefore be given to establishments which are called upon to extend. The status of the committee, as recently reorganised, gives us reason to believe that, whilst the interests of the public will be safeguarded, not less than justice will be done to the controlled owner who is giving of his

heat, without regard to overwork, and taking great financial risks in his splendid desire to "do his bit" for his country.

The Danger of Letting Things Slide.

If the war has done nothing else, it has, let us hope, convinced us of the danger of letting things slide. It is so fatally easy to allow matters to take their course if only our comfort be not interfered with! How many examples flash through the brain when a survey is taken of the happenings of the last three years. We have seen the supply of dye stuffs practically cut off, simply because in the past we allowed an industry, which had its inception in the invention of an Englishman, to drift into the hands of continental manufacturers. Spelter in pre-war times came to us largely from Germany, which had even managed to gain control of the output of mines in one of our own Colonies. The production of tungsten was almost entirely in German hands, and that country and Austria practically had the monopoly of certain kinds of glass. Hosts of little useful things were made by the Germans and by them alone, such as to give a homely instance, glove and dress fasteners. Our old tin cans even were bought up for a mere song, taken to the Fatherland, and so treated that by the recovery of the tin and iron a handsome profit was realised. The Germans, too, had made great inroads into the cement machinery and glass bottle making and fluid bottling machinery trades. In fact, we might go on almost indefinitely multiplying cases in which we were content to see things remain entirely in the hands of foreigners without pausing to consider what our condition would be if supplies were suddenly cut off. Enough, however, has been said for our present purpose. It is quite evident that our easy-going attitude of *laisser faire* permitted those with whom we are now fighting to get such a hold on us that on the outbreak of hostilities we were, to use a mild expression, considerably inconvenienced. It is true that as regards cement making machinery laudable efforts had, before the war, been made in this country to wrest some of the business from Germany, but these efforts were to a certain extent counteracted by the facts, first, that the Germans would cut prices so far as to supply machinery at less than cost price in order to keep British makers off the market, and, secondly, that they had cleverly spread broadcast the untrue assertion that nothing but German machinery would make good cement—an assertion which, unfortunately, was only too readily believed by a large proportion of our cement manufacturers. Moreover, these endeavours were in the nature of an exception, and were not widely copied.

The sting of the matter is that, while we were complacently accepting all these things as nothing extraordinary, and worrying not one whit about them, the Germans were by no means acting without purpose. There is no doubt whatever that for many years they had been plotting this world war, and had foreseen that there were other ways of fighting than simply with guns and explosives. They had, in fact, been working with a purpose while we were content to let things slide. Nor were we alone in this attitude. The United States have suffered in many respects, and, like ourselves, have had to put their house in order. Economies which previously had been absolutely neglected have had to be made. Before the war, for instance, the waste liquors from the scouring of wool were allowed to drain away, and no effort was made to recover the grease and potassium salts they contained, since the price of the latter, as obtained from Germany, was so low that it did not pay to recover them from the liquor. Germany, be it said, contains practically the only natural deposit of potash which is known to exist. Hence she was relied upon to provide it, and but few measures taken to find other sources of supply. Now, wool scouring liquor may contain from 105 lb. to 220 lb. of fat, and from 57 lb. to 78 lb. of potassium salts per thousand gallons, and successful processes of recovering both substances are in operation. We, ourselves, at last awakened from our lethargy, have been busy, and successfully busy, in many directions. We shall, in future, no longer have to depend entirely on Germany or Austria for certain kinds of glass, for spelter, or for tungsten. Many of the very numerous odds and ends which formerly came from one or other of the Central Empires are now being made in this country. There was no reason whatever why they should not have been made here long ago. In but comparatively few cases are there secrets in the manufacture, and what secrets there were or are have been or are being rapidly fathomed. No, it was not any inherent difficulties or any undiscovered secret which deterred us. It was, rather, that there were the goods to our hands, and we bought them. It would, of course, be absurd to say that nothing should be obtained from this or that country, for in that case there would be nothing which we could obtain in exchange of commodities of which we have the monopoly, or which we can produce more cheaply than the other countries. Hence, we cannot in future look forward to taking none of Germany's products, though, we fancy that prejudice against such products will last for many years to come. What we do maintain, however, and what we believe is really recognised by the nation at large, is that for things essential we should rely more on ourselves, and certainly not rely on one source almost entirely as we have hitherto done.

That which has happened during the past three years has certainly made us survey things generally in an entirely different light from that in which we were accustomed to regard them, and to ask the question "Is all well?" The answer to this inquiry cannot certainly be given, with truth, in the affirmative. All is not well everywhere. Possibly in nothing is it so far from being well as in our manner of using coal. It is true that long before the war many thinking minds had drawn attention to the heavy waste attending some of our methods of consuming this invaluable gift of Nature; but for the most part the warnings have passed, if not unheeded, at any rate, disregarded by the majority. The open fire is still indulged in with, consequently, the absolute loss of everything saving a small proportion of the heat of the fuel being utilised in any way, and that only in giving transient warmth to human bodies, and in preparing food. Even with the best of boilers and steam engines we do not obtain more than, say, one-twelfth of the total energy in coal, and we lose all the many other things it contains, which, if recovered, would represent a large value in money. We have long known and recognised these things, yet have we made any serious attempt to right the wrong? Have we not just let things slide? To a great extent we certainly have. True, we have sought to get as near to the theoretical thermodynamic efficiency as possible in boilers and engines, and some remarkable results have been achieved; yet even so we have wasted and are still wasting at least four-fifths of the possible energy of the coal, apart, entirely, from the absolute casting away of the by-products. Is it not time that this particularly important problem were much more energetically faced than it has been up to now? Nor are we alone in fault as regards the squandering of our coals. There are many directions in which waste is occurring in a fashion only a little less lamentable. The wealth in nitrates which, year by year, is literally flung from us by reason of our methods of sewage and refuse disposal is enormous. True, again, there are signs of reform in this direction, but for the most part there is apathy, the only desire being to reduce these so-called waste products into a condition in which they shall not be harmful to health. The theme might be enlarged upon, and other instances of waste might be adduced; but we have said enough. For the time being, and until the war is over, we must devote the whole of our energy to bringing the conflict to a successful termination. But let us not, simply because we must do this, allow all other considerations to escape our attention. Let us beware of repeating the mistakes of the past, and of permitting the perpetuation of malpractices. Let us frankly acknowledge that there are serious and vital problems to be tackled, and let us honestly grapple with them with all our might at the earliest opportunity. It will doubtless mean the discarding of many methods which have been practised by generation after generation; but mere sentiment must not be allowed to stand in the way of advance.

INSTITUTE OF METALS.

The autumn meeting of the Institute of Metals was held in the rooms of the Chemical Society, Burlington House, on September 19th, under the presidency of Sir George Beilby.

The new officers nominated for the ensuing year are: President, Professor H. C. H. Carpenter; vice-presidents, Mr. G. V. Boeddecker, Sir Thomas Rose, and Dr. Walter Rosenhain. Members of Council: Mr. L. Archbutt, Professor C. A. Edwards, Engineer Rear-Admiral George Goodwin, Sir Robert Hadfield, Mr. George Hughes, Dr. R. S. Hutton, and Sir William Smith.

The first paper taken was that by Dr. B. Parker Haigh, dealing with "Experiments on the Fatigue of Brasses."

The object of this paper is to describe a series of experiments on alloys which have hitherto received less attention in this respect than mild and alloyed steels. The phenomena of fatigue for brasses are generally similar to those for mild steel, and it is shown by the author that the effect of corrosion and fatigue are mutually associated, and that fatigue is accelerated and occurs under lower stresses when the conditions tend to promote corrosion. The experiments described dealt with the effects of annealing, the relation between the limiting range of stress required to produce fatigue, and the ratio between the maximum and minimum stresses; with the phenomena of elongation under stresses over the fatigue limit, but less than the ultimate tensile strength of the material, and the influence of corrosive reagents upon the endurance of the metals under alternating stress. The brasses used were obtained from commercial supplies in the form of ½ bolt staves, and included Muntz metal—58.0 copper, 41.2 zinc; naval brass, 58.5 copper, 40.1 zinc; naval brass, 66.3 copper, 32.2 zinc, and phosphor bronze.

In the discussion Mr. Arnold Philip referred to the influence of corrosion upon the limits of failure under alternating stresses. Corrosion was invariably accelerated owing to the movement of the metal through stress opening up surfaces which would otherwise be protected. The point was an important one in large boilers and metals in other classes of service.

Dr. C. H. Desch said the method used by the author was an exceedingly good one, and it was a great advantage to have a test in which the stresses were so perfectly defined. As to the influence of corrosion, the Bureau of Standards had made experiments on iron, and it was found that when the elastic limit was passed an amorphous film was produced which was associated with an acceleration of corrosive action.

Dr. W. Rosenhain considered the most important of the conclusions reached was that the phenomena of fatigue in non-ferrous metals were very similar to those found in steel. Another outstanding fact was the failure to determine any relation between the primary elastic range and the range of indefinite stresses under alternation. To what that might be due required further investigation. As to the connection between fatigue and corrosion, it was extremely interesting, and a point which occurred to him was to ask if parts of a machine covered with oil—conditions under which most machinery worked—were protected from the effects referred to by the oil film, as compared with a piece of clean metal tested in the laboratory.

Lieut. B. M. Jenkin referred to the question of metals used in aeroplane construction. He said it would be desirable to have information as to the best method of polishing, and to know if it was desirable to resort to burnishing to eliminate scratches on the metal.

Dr. Haigh, in a brief reply, said that oil in a machine under the conditions named was always decomposed very rapidly and carbonised. The question of scratches was somewhat difficult, but it seemed good practice to avoid burnishing. Another point was that many cases of fatigue were not due to anything but the absence of fillets in the design.

Sir George Beilby drew attention to the beneficial effects of annealing at about steam heat in preventing subsequent changes, and he recommended this method to avert the failures which had occurred in aeroplane work.

Professor Thomas Turner then presented the paper on "Hardness and Hardening," which is reprinted in to-day's issue.

Col. Belaiew dealt with the Brinell test. He desired to emphasise the need in applying this test to such a material as mild steel—to take a common example—to use great care, or otherwise divergent results might be obtained from different tests on the same material. The figure obtained might give the hardness of the general microstructure or that of particular crystals and constituents of the steel. For that reason the variations in the Brinell hardness numbers which were obtained need not be too seriously regarded for practical purposes.

Mr. Cosmo Johns was of opinion that the author had made an excellent attempt to restore order to a branch of metallurgy in which knowledge was in a somewhat chaotic state. The word "hardness" was very loosely used. He personally could not agree with the new definition of the author that hardness might be taken as the property whereby a body is able to penetrate another body or to withstand penetration. It seemed to him that resistance to abrasion was the true measure of hardness. The case of manganese steel might be mentioned. That steel, under cold work, apart from the formation of an amorphous phase, underwent a change of state. From being plastic with a high degree of elongation, it became hard with a very low degree of elongation. In his opinion simplicity would be restored if the term "amorphous phase" were dropped. It was necessary, in order to obtain a clear conception of hardness, to eliminate the consideration of qualities which had no relation to real hardness.

Dr. W. Rosenhain failed to see how the question of the definition of hardness could be settled by Mr. Cosmo John's method of reverting to the abrasion standard. Resistance to abrasion was by no means a simple problem, questions of tensile and shear strength and other factors being involved. The point which concerned users of metals was the hardness of the conglomerates of which practical materials were composed, in spite of the fact that the components of an alloy might differ in hardness. He would be inclined to regard hardness as the property of a surface rather than a material, and to define it as the stress per unit area which the surface could with-

stand without undergoing permanent deformation. The designing of an instrument to determine this limiting stress was somewhat difficult, and it would probably be necessary to be satisfied with a method which would produce a very small indentation. Professor Turner's suggestions were in many respects excellent, if not quite new.

Dr. W. H. Hatfield was much interested in the subject from the industrial standpoint, but regarded the attempt to define the property of hardness as a waste of energy. Instead of seeking for a definition it would be preferable to analyse the different properties which confer hardness on a material. It was well known that hardness, as determined by the Brinell test, did not give a reliable guide to the machining properties of the material. There were many anomalies in this respect. Mr. Cosmo Johns suggested that resistance to abrasion was the true measure of hardness, but that standard did not give a real indication of the wearing properties.

Mr. O. Ellis said that to those dealing with non-ferrous metals, which were so important at the present time, it might be of interest to know that a simple method of determining if the metal was cold hard when in the form of rod was to cut a slot down the middle of the rod along its length. In the testing of metals which had been subjected to cold work generally it was found that the density increased as the amount of cold work was increased—a fact which to a certain extent might be regarded as a proof of the soundness of the amorphous theory.

Dr. C. H. Desch pointed out that if hardness was to be defined as resistance to penetration, it was necessary to have a definition of what was meant by the term "penetration." The meaning of hardness in the mineralogical sense was resistance to surface cutting. That was a property of great importance in industry to-day, having the closest relation to the machining properties, and had much more value than an abrasion test. It was unfortunate that means of determining the resistance of a material to cutting were not more accurate. The Jaggers instrument, which was used by mineralogists, which had a very small diamond point, could be employed to determine the hardness of different constituents of a metal or alloy separately.

Professor Turner, in replying to some of the points raised, said stress had been laid on the distinction between the general average hardness and the hardness of different constituents. He would point out the need for distinguishing between static and dynamic hardness. Dr. Rosenhain's definition would be an admirable one if it were more fully worked out. Dr. Hatfield wanted to analyse the properties which constituted hardness, a suggestion which emphasised the need of first defining what was meant by the term. He did not agree with the suggestion that metallurgists should confine their idea of hardness to the mineralogical view of the subject. It would be unwise to take abrasion as a true test of hardness. A piece of hard steel would suffer abrasion much more quickly than copper, and experience had shown that such a test was not suitable for the determination of hardness properties. He came back to the point raised by Dr. Rosenhain, and which Osmond had suggested, that "hardness" was the ability to resist deformation, which obviously must include surface deformation.

THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

(*Continued from page* 227.)

PART II.

In the preceding part we have described the more systematic part of our work. After the return of peace we hope the nation will reap the fruits of these preparatory labours, and that progress will then be much more rapid. In this second part of our report we intend in the first place to give a short description of a number of investigations we have aided or initiated, some of them of great importance, and all of them entailing considerable work upon our Committees and upon those responsible for directing the researches. But they fall into no considered plan, and we have supported them because they are good in themselves and because in time of war one must do, not necessarily the best, but the best possible. They may well find their place later in some co-ordinated scheme or schemes of work, as already seems likely to happen in the near future in the case of some of them, such as the alloys researches at the National Physical Laboratory, the important corrosion research, the hard porcelain research at Stoke, and the refractories research at the same place.

In the later sections we refer to the assistance we have been able to give to individual research workers, and we discuss the two important problems of how best to encourage inventors and to assist individual manufacturers who want scientific assistance. We do not pretend to have found a complete solution for either problem, but we think our proposals may offer some contribution to the desired result.

Light Alloys.

The Institution of Mechanical Engineers have received a grant from the Department since 1915-16 in aid of a research into the properties and composition of alloys conducted at the National Physical Laboratory. The rapid growth of work at the Laboratory on aluminium alloys for the Advisory Committee on Aeronautics has reacted upon the work of the Alloys Research Committee of the Institution of Mechanical Engineers. The Department have accordingly made an additional grant to the Laboratory for this research, besides renewing their grant to the Mechanical Engineers during the current year. The foundry at the Laboratory has been extended, and the space available for the research doubled. "Much of this work overlaps and interlocks with that required for immediate aircraft purposes, but it was found possible to investigate a number of matters of broad and fundamental interest in connection with the whole question of aluminium alloys and their future use and development. The theoretical questions investigated, some of which suggested important practical steps, included further study of the equilibria of the ternary alloys of aluminium, zinc, and copper, and of aluminium-iron, aluminium-silicon, aluminium-magnesium and ternary alloys containing aluminium and two of these added elements."*

Corrosion of Non-Ferrous Metals.

The investigation into the corrosion of non-ferrous metals in sea-water initiated by the Institute of Metals and carried on during 1915-16 at the University of Liverpool has already yielded positive results which may prove of great practical value. As we reported last year † the research was transferred on October 1st to the Imperial College. The transfer enabled the conditions under which the research was being carried on to be greatly improved and its scope extended. With the assistance of the Brighton Corporation full-scale experiments running night and day were arranged under the general supervision of Captain Bengough, who was in charge of the research, while the necessary tubes have been supplied free of charge by firms in the industry. The rapid progress made since last October has been due to the undivided attention which Captain Bengough has been able to give to the work and to the favourable conditions we have been able to secure for its conduct. If a scheme of work is carefully laid out, if adequate provision for experimentation is provided, if well-equipped investigators are set to work without anxiety, as to ways or means or the distraction of other duties, in close touch with other scientific workers and the resources of well-found libraries, the advance made will be infinitely more rapid than is possible in less advantageous circumstances. Captain Bengough had devoted his spare time for years to the problem of corrosion, working with such equipment and assistance as he could secure with the exiguous means our Universities for the most part command. The progress now made is not the result of the large scale tests—valuable as these are likely to prove—but the result of systematic laboratory attack. The research has now been extended, on the initiative and with the assistance of the British Electrical and Allied Manufacturers' Association to cover corrosion of condenser tubes in service on land. The Committee of Council have made a further grant for this purpose; the investigation will be carried out under the direction of a joint committee of the British Electrical and Allied Manufacturers' Association and the Institute of Metals. An experimental condenser plant will be provided under conditions as to place and working to be determined by the Corrosion Research Committee of the Institute of Metals. At a later date it is proposed to extend the inquiry into the corrosion of non-ferrous metals under atmospheric conditions, the need for which research has been pointed out by the Royal Institute of British Architects.

Refractories.

The Institution of Gas Engineers have long supported a research under Dr. Mellor into refractories, conducted at the Central School of Science and Technology at Stoke. The growth in this work has led the authorities of the school to approach the Department for aid towards the cost of a much-needed extension of their laboratory for refractories. The Council view the work of Dr. Mellor in this field with sympathy, and they recognise that the problems connected with refractory materials call for greatly increased attention. Indeed, the matter is of such wide interest that a Refractories Conference has recently been summoned on the initiative of the Faraday Society, at which no less than thirteen societies and bodies were represented, with a view to working out a co-ordinated scheme of attack on a national scale. The Council agree that nothing less comprehensive would be satisfactory, and they await the proposals likely to be formulated by the Conference with great interest. Any scheme to be satisfactory must find a proper place not only for the work which has so long been carried on at Stoke, but also for that more recently begun with valuable results at the National Physical Laboratory, as well as for that in contemplation at Sheffield and elsewhere. This problem affords an excellent example of the need for well-considered action. Refractories are a vital necessity for many difficult laboratory investigations, and in many diverse industries. The difficulties to be overcome are too many and too varied to be adequately dealt with in one place or by a single group of workers. The need for co-operation and for the assignment of the proper work to each is obvious.

Hard Porcelain.

The other important research being conducted at the Stoke school under Dr. Mellor and Mr. Bernard Moore is making very satisfactory progress; it is an attempt to produce a marketable hard porcelain from purely British material. The investigation is being financed by the Staffordshire Pottery Manufacturers' Association, jointly with the Staffordshire and Stoke Local Education Authorities and the Committee of Council. The problem of firing has proved easier than was expected, and though details cannot yet be announced we understand that a ware has already been produced which is expected to prove cheaper than English earthenware, to be susceptible of satisfactory decoration, and while felspathic in body to have some of the best characteristics of English bone china. A cheap and new glaze has also been developed.

Hardness Tests for Journals and Pins.

The Institution of Mechanical Engineers had since 1914 financed a research into hardness tests for journals and pins conducted at the National Physical Laboratory. The Committee of Council made a grant last year to the Institution in aid of this research, and have since renewed it for the current year. The Institution is indebted to Sir Robert Hadfield for supplying materials, and for offering a prize of £200 for the discovery of a quick and accurate method of determining extreme hardness.

Flow of Steam through Nozzles.

Another research, proposed by the Institution of Mechanical Engineers, was originally planned upon a scale which the circumstances of the time made impracticable. The flow of steam through nozzles is a matter of deep importance to steam turbine manufacturers, and the Council recommended a grant for a series of preliminary investigations in which the University of Manchester, the Royal Technical College, Glasgow, the British Westinghouse Company and the British Thomson-Houston Company are taking part.

Heating of Buried Cables.

A research at the National Physical Laboratory into the heating of buried cables, planned by the Institution of Electrical Engineers more than four years ago, had been held up through lack of funds until the Committee of Council made a considerable grant on our advice. The work was put in hand early in 1916, and the experimental cables are now all laid and connected except one. The installation of apparatus in the huts is complete, and regular observations are in progress. The cables, which are all paper-insulated, include armoured cables laid direct in the ground, cables laid solid in bitumen, and cables drawn into a six-way stoneware duct. Concurrently with this work, and with the aid of the Department, extensive research has also been carried out for the Institution of Electrical Engineers at the University of Liverpool under the direction of Professor E. W. Marchant and Mr. F. J. Teago. A careful study has been made of the heating of feeder cables of various sections laid in stoneware troughs filled with bitumen at a depth of about 3ft. below ground.

Insulating Oils.

Another research, initiated by the Institution of Electrical Engineers into the properties of insulating oils and aided by the Department, has been carried out with the assistance of a number of important engineering laboratories and firms, who have placed the services of their technical staffs and their works, together with a considerable quantity of oil, at the disposal of the research. The Council note with satisfaction from the report of the Institution that a careful collation of existing information was undertaken before laying down the programme of new work.* The research had already been in progress three years before it was aided by the Department. Its objects were to ascertain in the case of oils used commercially for the insulation of transformers and switches:—(*a*) The characteristics to be required in specifying oils, best suited to the purposes stated; (*b*) the effect upon the physical and electrical properties of the oils of (i.) the formation of sludge, (ii.) the absorption of moisture, and (iii.) the occurrence of thermal transference; (*c*) the nature of the substances produced during normal working conditions when the above-mentioned processes are taking place.

After experiments instituted to determine the character of the tests to be applied, apparatus was devised and detailed methods of testing specified for a series of characteristics ranging from "tendency to sludge" to "specific heat." Samples of varieties of oil were sent to six investigators with requests to carry out the test as to sludging, and as many of the following tests as possible. Reports received show that considerable progress has been made, but some delay has been caused by difficulty in obtaining certain glass apparatus and by the lack of laboratory assistance due to the war.

Heat Treatment of High-Speed Steel.

Valuable results have emerged from the experiments in the heat treatment of high-speed steel which have been conducted for some time past by Mr. Dempster Smith for the Manchester Association of Engineers at the School of Technology in that city. The Department made a grant in 1915-16 sufficient to cover the cost of the research, with the exception of certain materials and apparatus—found by the firms in the Association—and the cost of housing, light, and power, which were contributed by the School of Technology. Mr. Dempster Smith has succeeded in standardising the heat treatment of high-speed steel in a manner which, though not susceptible of protection by patent, has been of great value to the Admiralty in the manufacture of certain implements of war. The Council think that Mr. Smith's results may be of much wider application than this, and the Ministry of Munitions are publishing a memorandum in their Journal, explaining the methods to be adopted. The experiments are being continued under the supervision of Mr. Dempster Smith, although he has left the staff of the School of Technology to enter the service of an important firm of engineers. The Council hope that as time goes on there may be more passage of this kind from Universities to manufacture as well as from industry to the University.

(*To be continued.*)

THE NEW QUEBEC BRIDGE.

The raising of the new central span of the Quebec Bridge was commenced on the 17th, and was continued on the 18th without incident. The total hoist is about 150ft., and according to information received in London on the 19th about half this distance had been successfully accomplished. The span is a duplicate of that which fell into the river during the hoisting operations on September 11th, 1916, and is being raised, we understand, by substantially the same design of lifting tackle. In the present case, however, the hoisting operations are being spread over several days, whereas a year ago they were intended to be completed within one day.

* National Physical Laboratory. Report on the Department of Metallurgy and Metallurgical Chemistry for the year ended March 31st, 1917, page 61.

† Report of the Committee of the Privy Council for Scientific and Industrial Research, 1915-16, page 49. [Cd. 8336.]

* See *Journal* of the Institution of Electrical Engineers, Vol. 53, No. 239.

PUSH-BUTTON COAL AND ASH HOISTS.

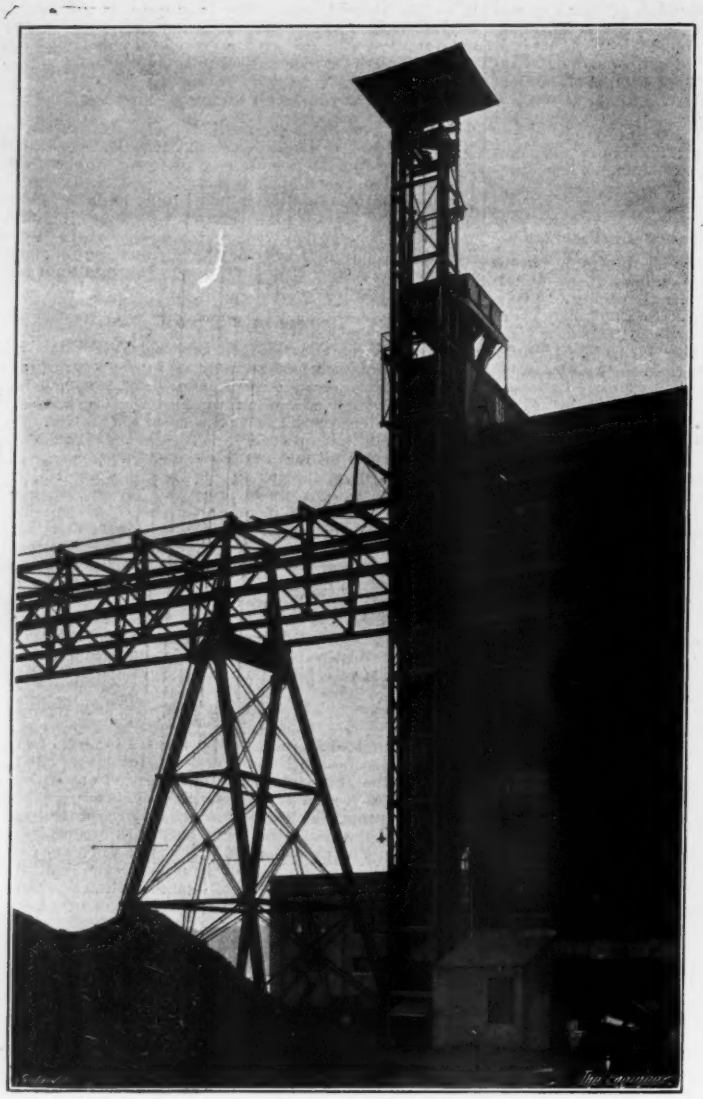


Fig. 1—HOIST AT BALTIMORE

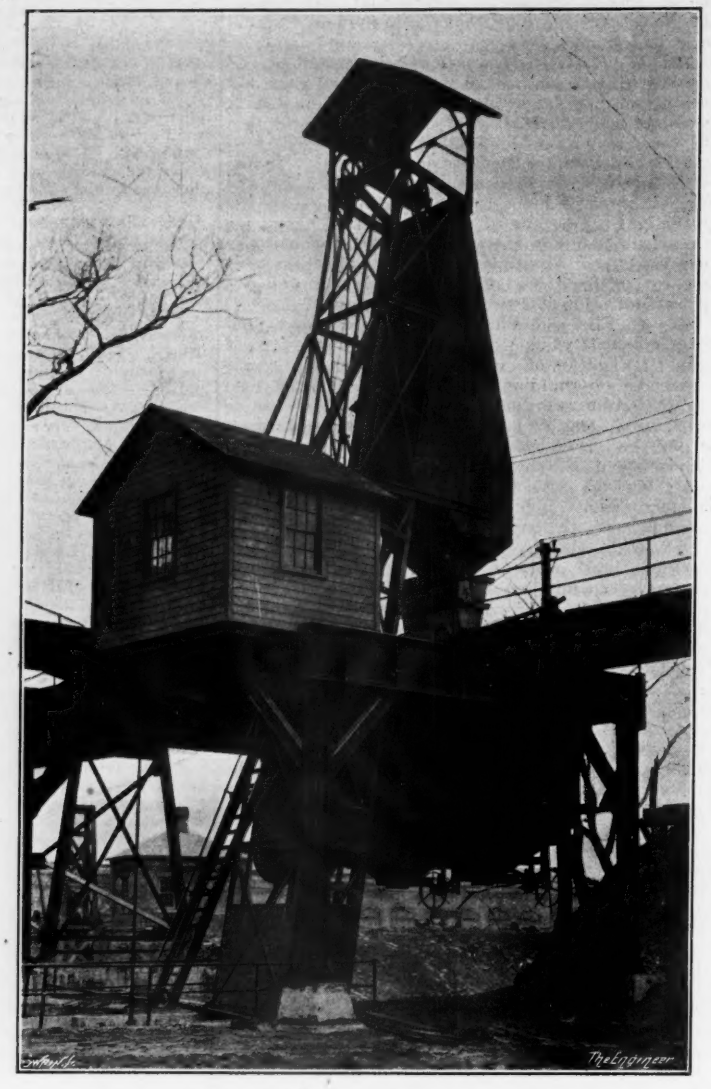


Fig. 2—HOIST AT ALLISON

PUSH-BUTTON COAL AND ASH HOISTS.

THE mechanical handling of coal, coke, and ashes in gas plant operation rapidly is becoming a problem which is engaging the attention of engineers of to-day, and the accompanying illustrations—Figs. 1 and 2—showing an automatic coal and ash hoist, with push-button control, installed by the Consolidated Gas, Electric Light and Power Company, of Baltimore, Md., and at the plant of W. J. Rainey Company, at Allison, Pa., will be studied here with some interest. The saving in labour costs made possible by such equipment, together with the resulting freedom from labour difficulties which may arise at any time are factors which have brought about the adoption of such hoists by gas companies.

In the hoist, illustrated in Fig. 1, the material to be raised is dumped into the open top of a bucket, which is supported and held in a vertical position, in a frame running in vertical guides. Suitable hoisting cables are attached to the upper part of this frame and led over sheaves to the drum of a worm gear elevator winch which is, of course, motor driven. The bucket is made of heavy steel plates, and is provided with two angle iron cams, one on each side, which, as the bucket approaches the top of the tower, engage with rollers, which control the swing of the bucket, and cause it to tip the contents. When the bucket has reached the dumping position the machine automatically stops, and remains at rest long enough to permit the discharge to be completed. This interval varies from two to ten seconds, according to the nature and quantity of material handled, and the equipment is provided with a simple adjustable timing device that permits of readily obtaining this variation. At the end of this dumping interval the machine automatically starts in the reverse direction, and the bucket regains its vertical position in the frame, and travels down to the level from which it started, ready to receive another load. The attendant who operates the hoist usually controls the delivery of material into the bucket. The operation of the hoist itself is extremely simple, inasmuch as once started by a momentary pressure of the push button, the bucket proceeds to the top, where it automatically dumps its load and returns to the starting position without further attention.

It is claimed that this is an extremely desirable feature, since it eliminates the expense of a special operator and avoids all possibility of damage due to inaccurate operation. The controlling device is arranged for either direct or alternating current, and is of the standard Otis patented full magnetic type, operated by push buttons conveniently placed at the loading level. Three buttons are provided, one for up-motion, one for down-motion, and one for stopping the motion at any time it is desired to do so.

We are informed that this type of hoist has a carrying capacity of from 1000 lb. to 10,000 lb. at a bucket speed varying from 50ft. to 150ft. per minute, depending upon the load carried. Fig. 2 shows the upper part of a somewhat similar hoist at Allison which is set a little off the vertical.

HARDNESS AND HARDENING.*

By Professor T. TURNER, M.Sc., A.R.S.M. (University of Birmingham), Vice-President.

HARDNESS is a property which is of great importance in connection with the practical uses of metals. This is evidenced by the numerous methods which have been introduced from time to time for testing hardness, and also by the abundant literature which has been published on the subject. The latest contribution to this study is a "Report of the Hardness Test Research Committee of the Institution of Mechanical Engineers" (November, 1916), in connection with which a bibliography has been prepared. I have been privileged to assist in the preparation of this bibliography, which contains references to some 131 papers and other publications dealing with hardness and hardness tests. Even this list does not touch the question of hardening, which has been discussed by Sir George Beilby, Professor Edwards, Mr. McCance, the present writer, and many others. To the report above mentioned three appendices are attached, which give the views on the nature of hardness of Professor Unwin, Sir R. Hadfield, and Dr. Tutton respectively. From these appendices, which are of great interest, it is evident that the members of the committee, and those who took part in the discussion, are not agreed upon the fundamental conceptions as to the nature and definition of that which they were endeavouring to measure.

Definitions and Measurement of Hardness.—It has been frequently stated that hardness is a property which cannot be measured or readily defined. This is merely another way of saying that we have not made up our minds as to what we mean by the term "hardness," for there is little difficulty in framing a definition when once a clear mental conception is reached. That which can be accurately defined is capable of measurement.

Though so eminent an authority as the late M. F. Osmond has used the word "measurement" in connection with hardness tests—see report *Sur la Dureté : sa définition et sa mesure*, Paris, 1892—physicists appear to have pretty generally expressed the view that hardness cannot be measured. Professor H. Le Chatelier, in discussing the "Report of the Hardness Tests Research Committee" (page 777), admirably states this view as follows: "Two simple characteristics determined whether a quantity might be measured or not. If measurable, it should satisfy the laws of equivalence and accumulation. Temperature, though it followed the law of equivalence, did not follow that of accumulation. For instance, two bodies raised to the same temperature would not give a higher temperature if brought together. So that temperature could not be measured—all that could be done was to register it on certain scales. . . . Hardness was exactly the quantity which followed neither the law of equivalence nor that of accumulation."

It may be dangerous for one who can make no claim to be a physicist to differ from so recognised an authority as Professor Le Chatelier. On the other hand, it may be inconvenient to take words which have been familiar for centuries, and to endeavour to limit their application to the specialised uses of modern science. In the present instance it may be pointed out that a property is not necessarily a quantity; and it would scarcely be urged that hardness is a quantity in the sense of the physicist. Further, it may be remembered that the word "measure" has a much wider use in our language than is suggested by the laws of equivalence and accumulation.

What we require for practical purposes, is to be able to register hardness on a numerical scale, just as we do density, tenacity, viscosity, or other properties. For example, we determine relative density; it does not follow the law of accumulation, because if two bodies of the same density are brought together the density is not doubled—unless they are gases which can be compressed into half their original space. The determination is accurate, and similar results are obtained on repetition. Shall we say the density has been measured; or has it only been registered or determined? To the physicist the choice of a word here may be important. But the ordinary reader might be misled if he were told that the density, or the elastic limit, of a metal cannot be measured.

The definition which I myself prefer is that hardness is the property whereby a body is able to penetrate another body; and conversely, it is the property whereby a body resists being itself penetrated. This does not materially differ from the definition proposed by M. Osmond in 1892, that hardness is "resistance to permanent deformation." Sir Robert Hadfield's definition is simply "resistance to deformation." From the mechanical aspect, hardness, as so defined, will closely correspond with the "yield point" or "breaking-down point" of the material. In ductile materials, such as relatively pure metals, of which mild steel is an example, the yield point is often roughly proportional to the ultimate tensile strength. In such cases the hardness, as measured by the stress per unit of area required to produce penetration, is less than, but varies with, the tenacity. In brittle materials the yield point and the ultimate strength are practically identical: in such cases tenacity and hardness will nearly coincide. The hardness may, however, exceed the tenacity, since in a tensile test the particles are drawn away or separated

* Institute of Metals, September, 1917.

from each other, while in a penetration test there is a certain amount of "backing" in the material, which tends to support the penetrating body.

With penetration tests, such as those of Brinell, in which an appreciable quantity of metal is displaced, the true hardness is not obtained, since the displaced material becomes more or less work-hardened, and another similar test on the same spot will not give the same result. The difference may, however, not be large. In wearing tests the polishing, and consequent hardening, of the rubbing surfaces on the one hand, or their disintegration on the other, may lead to quite erroneous conclusions. Theoretically, the production of a scratch of standard width, and of indefinite thinness, with the employment of an ascertained weight, would appear to most nearly meet the ideal conception. For practical purposes the requirement of a smooth surface, and the difficulty of accurately deciding the character of the scratch, has prevented the extensive use of scratching tests by engineers, though such tests are still preferred by mineralogists and other workers. The conception underlying the Brinell test is a simple one—namely, that a unit of surface will just maintain a stated pressure before being deformed. So long as the amount of deformation of the sample is not excessive, and provided the body to be tested is not brittle, the Brinell hardness number closely corresponds with true physical hardness.

Resistance to Wear.—For many purposes, however, the engineer does not really require hardness, though he asks for it. What he does desire is resistance to wear, or to deformation, or some other property or combination of properties which are of importance for the particular purpose he has in view. Thus, if we consider a wearing or grinding test, it is necessary, if the metal is not to wear away quickly, (1) that the particles on the surface shall not be readily displaced, and (2) that the particles so displaced shall not be readily removed. Both conditions are necessary; either alone is not sufficient. Substances which are really hard do not permit of their particles being readily displaced—hence they wear well. Plastic metals do not permit of their displaced particles being readily removed—hence they, too, may give good wearing surfaces, though they are really very soft. The wearing properties of manganese steel, for instance, would appear to be due to two causes: (1) The relatively high natural hardness of the material itself; (2) the fact that the particles which are displaced from the surface do not come away and form a powder, but are plastically spread over other parts of the surface; they are thus capable of being repeatedly displaced, and are work-hardened before being ultimately lost.

A number of unfortunate terms have been introduced during the last few years, such as "tensile hardness," "wearing hardness," "elastic hardness," and so forth. These terms are misnomers. Thus tensile hardness is merely tenacity; but tenacity indirectly measured by some apparatus which is found to give results which, when multiplied by a suitable factor, are approximately the same as those obtained by the tensile testing machine. This term has been almost exclusively used in connection with tests of mild steel, such as is used for constructional purposes and for somewhat harder material as employed for rails. In such cases, as has been already pointed out, the true hardness is less than, though approximately proportional to, the ultimate tensile strength.

Hardness of Pure Metals.—If attention were confined to the pure metals in their cast, annealed, or unwrought condition, the question would be much simplified, for the hardness varies inversely as the atomic volume. In other words, the hardness increases as the number of atoms in a unit space increases. Mr. S. W. Smith has also shown that with liquid metals surface tension varies inversely as some function of the atomic volume,[2] while Dr. F. C. Thompson suggests that the elastic limit is dependent upon surface tension. Dr. Tutton has shown that with a number of substances other than metals, the hardness varies as the molecular volume, provided always that similar materials are compared. Dr. Tutton has also pointed out that it may be anticipated in crystallised substances, owing to the arrangement of atoms in the crystals, there may be some differences of hardness in different directions in the same crystal.

It is frequently stated that pure metals are not to be obtained commercially; but it is worthy of remark how exceedingly pure some commercial samples of metal really are. Thus lead, tin, and zinc are sold by the ton with an analysis which shows 99.95 per cent. of the respective metal, and only one part in two thousand of total impurity. But for the majority of purposes pure metals are too soft, and must be hardened in some way.

Methods of Hardening.—There are three methods whereby the hardness of a pure metal may be increased: (1) by alloying; (2) by cold working; (3) by chilling.

Chilling may be regarded as a combination or variation of the first two methods. It may lead to the setting up of internal strains, which really produce the effect of cold work; or it may change the chemical composition of an alloy by causing some constituent to remain in solution, or even prevent a constituent from going into solution. The hardening of steel, and the softening of certain bronzes, by chilling, are examples of this effect on internal composition. Ultimately, therefore, metals or alloys can only be hardened by a change of composition or by strain.

When we add to one metal another metal, or other element, and allow the product to solidify, the result is a mixture, a compound, an eutectic, or a solid solution. The useful ductile alloys are, almost without exception, solid solutions. Since this fact has been recognised, special attention has been given to the nature and properties of metallic solid solutions, and some important generalisations are now fairly well known.[3]

Hardness of Solid Solution.—As we pass from either end of a series of solid solutions towards the centre of the series it will be found that the hardness, the limit of elasticity, and the tensile strength increase, but the ductility—as measured by the extension and the reduction of area—and the electrical conductivity decrease. The melting point usually changes fairly regularly throughout the series. These facts for a series of solid solutions of a metal A, and any other metal, metallic compound, or non-metal B, which forms a series of solid solutions with the metal A, may be diagrammatically represented in the simplest possible manner, as in Fig. 1.

If a series of solid solutions be interrupted by the presence of compounds, or of eutectics, this will be indicated by

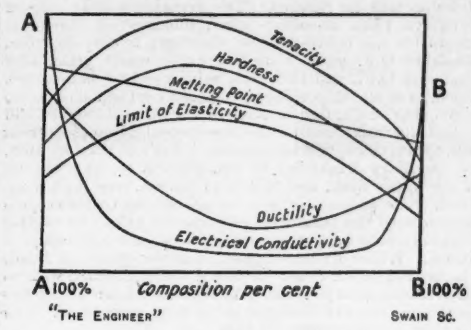


Fig. 1

irregularities in the hardness and other physical properties, at such points as correspond with the end of the series in the respective cases.

It will thus be seen that it is possible to harden either constituent by addition of moderate proportions of the other. At the same time the material becomes less ductile—in other words, more brittle. A point is frequently reached at which the tenacity can no longer be increased with safety, owing to the continued increase in brittleness. But the metals we add do not necessarily diminish the ductility in their alloys at the same rate as they increase the tensile strength. For example, nickel, copper, manganese, or chromium may be added to steel in such proportions that the improvement in tenacity is much greater than the deterioration in ductility. Hence the application of such metals, in suitable proportions, in steels for special purposes.

In the copper alloys the same general principles are adopted. The proportion of zinc which can be added to copper, in order to strengthen it, is limited by the loss of ductility, having regard to the purpose in view. For ductile brasses, as is well known, the limit of zinc is usually about 30 per cent. Small quantities of iron or of manganese may increase the tenacity more rapidly than they deteriorate the ductility. Of this we have examples in the manganese and iron brasses.

It is stated in the "Ninth Report of the Alloys Research Committee"—page 133—that the effect of adding manganese to an alloy of copper and aluminium was to raise its yield point and tensile strength without reducing its ductility to a corresponding extent. With increased knowledge of the effects produced by relatively small additions of the less common metals to our alloys, it is probable that a useful field will be opened for increasing their hardness without producing brittleness.[4]

Hardening by Cold Work.—Turning now to the hardening of metals by cold working, it is well known, to those interested in the wrought metal industries, that the effect of such processes upon the mechanical properties of many metals and alloys is remarkable. The yield point and tensile strength are raised, while the elongation and reduction in area—or ductility—are markedly lowered. The electrical conductivity is only slightly affected. Further work put upon the metal causes it to fracture. By suitable annealing the material may be rendered soft and ductile as before. The material in its wrought state not only has greater strength, but is also harder than the original metal or alloy. But when that hardness is measured by different instruments, such as the sclerometer, the scleroscope, or the Brinell tester, it is not found that the values obtained are in agreement. Hence the hardness produced by cold working is different in kind from that resulting from the alloying we have previously discussed.

It might, perhaps, be assumed that rolling, hammering, or pressing a metal would render it more dense, and that the observed increase of hardness is due to such added density. But any change of density due to mechanical processes is far too small to permit of being explained on the principle of atomic volume. Further, as a matter of fact, the change is ultimately in the opposite direction. The first result of pressure is to close up any pores, cracks, or blow-holes, and thus to increase the apparent density; hence bars are usually more dense than the ingots from which they have been rolled. The subsequent effect of cold working is to slightly but appreciably diminish the relative density of the worked material. It is important to consider how this change is brought about.

If a piece of metal be stressed to any extent below its elastic limit, and the stress is removed, the metal returns to its original form and volume, and no hardening results. But if the stress be increased, so that the elastic limit is passed, permanent stretching or strain results, and the metal becomes worked hard. This stretching or deformation occurs, as has been shown by Rosenhain and other workers, chiefly, if not entirely, by shearing slip along planes of internal crystal symmetry. It matters not whether the force be applied in the form of a pull of a tensile machine, a blow as from a hammer, or pressure as in a compression test; there is no hardening unless there has been shearing flow, and this flow generally, if not universally, results in a small but appreciable diminution of density.[5] We may profitably inquire how this change of density originates.

Cause of Work Hardness.—If we imagine a solid crystal which is under strain, as a result of which shear occurs along a plane of crystal symmetry, it will be evident that at the moment the particles are pushed asunder, and caused to slide upon each other, they were clinging to each other, and were separated only with difficulty, and by what we usually call a "pull" of sufficient strength. The materials thus clinging to each other, and forcibly separated, were in a state of tension. It would, therefore, appear that the intervening layer of "amorphous" material cannot be in a normal or unstrained condition, neither can it be in compression; it must, therefore, be in a state of tension. When a bar of metal is in tension it becomes longer, and the extension is proportional to the stress applied. But in such a case the bar becomes thinner as it elongates; so the extension must not be regarded as indicating any volume change. Yet doubtless there is a small, but nevertheless real, volume change when a bar is stretched or compressed. It is just as real as the expansion of a gas on reducing the pressure, though almost indefinitely smaller in amount. It is this volume change, due to tension, which leads to the observed diminution of density in wrought metals.

That diminution of density does result from cold working has been shown experimentally by many observers. Thus Brunton found that in drawing steel wire its specific gravity could be increased from 7.768 to 7.998 by cold work, but that when this point was reached further drawing caused the density to decrease. Kahlbaum has shown that the density of platinum wire is reduced from 21.43 to 21.41 by wire drawing. Lowry and Parker found that metallic filings are in a worked hard condition, and that by annealing their density increased. Professor Lea, of Birmingham, has found that the density of mild steel is diminished if it be subjected to compressive stress which leads to distortion. Lastly, it may be recalled that Professor Heyn, in his May Lecture,[6] has proved that in cold-rolled bars the outside is in tension and the inside in compression.

Hardness and Tension.—When steel, which contains carbon, is hardened by means of rapid cooling, it is well known that the density of the hard steel is less than that of the soft or annealed material. Hence Professor J. W. Langley suggested the hypothesis that hardness corresponds with a condition of internal tension, and softness with the absence of tension. H. E. Field,[7] a little later, suggested that the hardening of iron is due to the particles being forced and held farther and farther apart, whether by heat or mechanical means. W. Metcalf, in discussing Field's paper, stated that cold working reduces specific gravity, while it increases the hardness, tensile, transverse, and torsional strength. He has also proved by actual measurement and weighing, on a commercial scale, that the density of cold-rolled wrought iron bars was less than that of the original metal.

These tests were conducted at Messrs. Jones and Laughlin's works when Mr. Metcalf was acting as assistant to Major W. Wade. Specific gravity tests showed that the cold-rolled iron was less dense than the hot-rolled bars. Major Wade was so surprised with the results that he arranged for a number of samples to be weighed, without vouchsafing any reason. Mr. Metcalf's results agreed with those of Major Wade, but they were so contrary to what was then the general theory that further tests were made. Hot-rolled bars were pickled, cleaned, carefully measured, and the cubic contents calculated. They were then cold rolled and carefully measured, when it was found that the increase of length more than compensated for the reduction in diameter. Many similar examples could readily be found.

Films in Tension.—The conception of stretched layers existing between the particles of a cold worked metal, or at the surface of a polished metal, has led various thinkers, and especially our President, Sir George Beilby, to recognise the similarity which must exist between such layers, and the surface tension with which we are familiar in liquids. This surface tension leads to the formation of so strong a skin upon water that a fly can walk upon it, or a greased needle float. But it would be unwise to assume, because there are some obvious similarities, that, therefore, all the laws which are applicable in the one case are equally true in the other.

It is evident that if a membrane is to be stretched there must be some body to which it can be attached, or to which it can adhere. The head of a drum is an illustration of this fact. In the case of a liquid drop the skin extends all around; but in other instances the film support is supplied by the sides of the containing vessel. It is interesting to inquire how the planes can remain stretched in a solid body, such as a cold worked metal.

If we could imagine the extreme case of the whole of the crystalline material being converted into the amorphous state, and all the planes being parallel to the length of the body, we should have an impossible condition, since all the layers would be in extension, with nothing to keep them extended. This could only exist with a body acting under external tensile stress. Such a body would be incapable of shearing strain; its yield point and its ultimate stress would coincide; it would be brittle like glass. Glass is brittle because there are no planes of shear. But in the case of a metal or alloy consisting of mixed crystals, differently oriented, strain leads to the production of a series of slip planes in each crystal aggregate. Adjoining areas, as viewed in a microscopic section, have their planes at various angles to each other, owing to the different arrangement of the component micro-crystals in each crystal aggregate. These planes, or thin films of amorphous material, may be regarded as being held in tension either by the rigidity of the crystal envelope—or cement—or by the mass of the unchanged material, or by both of these. But in ordinary mechanical processes, such as rolling, hammering, or drawing, we have not to deal with a single deformation, and one set of shearing planes in each crystal grain. Deformation follows deformation, and planes are set up in many directions. These slip planes cross and recross each other, their direction being limited only by the necessities of crystal symmetry. A section thus shows a network of crossing lines, each of which we assume to correspond with an extremely thin layer in tension. We have in such a section an intricate network, which is held together by tightly stretched strings or tapes, and supported by intervening, unaltered crystalline material. When we remember the great strength of a lattice girder, or of woven wire, we can more readily understand how these extremely thin layers of amorphous material, all of which are in tension, are able to confer great tenacity and hard-

[2] *Journal* of the Institute of Metals, No. 2, 1914, vol. xii., page 206.
[3] See Kurnakow and Shemtschushny, *Journal* of the Russian Physical Chemical Society, 1908, vol. xi., page 1067; also Dr. Desch, "The Hardness of Solid Solutions," *Faraday Society Discussion*, 1914, page 46.

[4] P. Ludwik has recently published a research dealing with the hardness of a large number of alloys—Abstract, *The Ironmonger*, April 7th, 1917.
[5] I understand that when coinage blanks are pressed there is an increase of density. If this is so it must be regarded as a special case, as the specimen is practically in a closed box and is not free to expand.

[6] *Journal* of the Institute of Metals, No. 2, 1914, vol. xii., page 18.
[7] Bulletin of the American Institute of Mining Engineers, 1908, page 571.

ness upon a worked ductile metal. The fact, referred to by Rosenhain, that metal which has been hardened against tension is softened against compression, is entirely in harmony with the foregoing explanation. But since the whole of the crystalline material never is, and never can be, completely converted into the amorphous condition, it follows that there must be unequal hardness and unequal tenacity throughout the various portions of the worked hard material.

Herein lies the essential difference in the character of the added hardness which is conferred by alloying and by cold working respectively. In the case of alloying we deal as a rule with a solid solution, which as a result of osmotic pressure is in a state of molecular tension, and every unit of which is of similar composition. It is true that with castings "coreing" occurs, but that does not really affect the argument. With a solid solution various methods of testing hardness should give results which are in general agreement. Worked hard metals, on the other hand, are less uniform in hardness, and if tested in various ways may give different results, depending upon the character of test selected.

Limits of Work Hardening.—It may be of interest to consider to what extent a metal may be hardened, or have its tenacity increased, as a result of cold working. It is difficult to suppose that any means could be found whereby the tenacity of a film of metal could be made to exceed the tenacity of a thin polished film at the surface—that is to say, to exceed the surface tension. Now Quincke calculated the capillarity constant of certain solid metals and alloys, or, in other words, the pull exerted upon one millimetre of surface. With iron, silver, and gold the ratios of the hard to the annealed state were about 3 or 4 to 1. With certain alloys it was less than 2. With steel it was about 7 to 1. These values must be regarded as rough approximations, and merely indicate the kind of numbers with which we have to deal. What they do show is that even if the whole of a sample of metal could be converted into material having the properties of a surface film, there is a definite limit to the hardness which could be imparted by the processes of cold working. In other words, after a certain point had been reached further work would not confer greater hardness, but would cause fracture.

But if it be true, as before suggested, that it is impossible to convert the whole of any metal into thin films, in a parallel direction, then it would follow that the attainable limit for increased hardness is below the figures which have been previously mentioned. In practice, for example, cast copper has a tenacity of from about 10 to 14 tons per square inch. When it has been drawn as far as is mechanically possible, in view of the purposes to which it is to be applied, its tenacity is from about 24 to 28 tons. Roughly, therefore, its tenacity has been doubled. In some cases less than this is possible; in exceptional cases more can be obtained. But always the maximum is only a small multiple of the original.

Even if we had information as to the proportion of the mass which had been converted in stretched films, it would not appear possible to calculate what the increased hardness or tenacity should be, and so check it by experiment. For if we accept the view that these planes are like so many strong bands passing through the material; that they are of varying length, and crossing and interlocking with each other at an indefinite variety of angles, it will be seen that we are dealing with a system of astonishing complexity which none of the usual methods of examining stresses would be able to unravel.

In a recent paper by P. Ludwik,[8] of which I have only as yet seen an abstract, the view is expressed that the phenomena of cold working are not explicable by Sir George Beilby's amorphous hypothesis, or by Tamman's translation hypothesis. Ludwik draws attention to the fact, which had already been stated by Professor H. M. Howe, and carefully studied by Matthewson, that the greater the amount of mechanical work the lower is the temperature at which softening takes place on annealing. In the foregoing remarks I have endeavoured to show that if it be assumed that the amorphous material exists in the condition of thin films, in tension, akin to surface films of liquids, then the results of cold working can be readily understood. And it would appear to follow that the more numerous these films are, and the more they are strained, the more readily will they tend to adjust themselves as the temperature is raised

THE AMERICAN NAVY AND MERCANTILE MARINE.

SIDE by side with a large programme of vessels for special war service, such as destroyers and submarine chasers, the United States Government is proceeding steadily with the completion of vessels that were authorised in advance of the war, and apparently has no intention of suspending the construction of capital ships, as was reported in certain quarters. American naval periodicals just to hand record the launch of the battleship Idaho on June 30th. This vessel and her sister ship, the Mississippi, which is already in the water, are, in a sense, "replace ships" for the two pre-dreadnoughts that originally bore these names, and were sold to the Greek Government a few years ago. The latter were renamed Kilkis and Lemnos. The American naval programme of 1914 made provision for two battleships only; but it was subsequently decided to build a third ship, partly out of the proceeds of the sale of the ex-Idaho and ex-Mississippi. With the launch of the Idaho all three vessels of the 1914 programme are now afloat. They are practically identical in design with the Pennsylvania and Arizona, already completed, and also with two later ships, the California and Tennessee, now under construction. When these two last-named are in commission the United States navy will possess its largest homogeneous squadron of all-big-gun battleships, comprising seven units, and the total strength of the dreadnought fleet will have been increased to nineteen vessels. The keel of the Idaho was laid by the New York Shipbuilding Company at Camden, N.J., on January 20th, 1915, so that she was on the stocks for the unusually long period of 29 months. The contract date of completion is November 9th next, but as the launch took place less than three months ago, it is obvious that the completion of the ship will be considerably delayed. The principal dimensions of the class are as follows:—Length between perpendiculars, 600ft.; beam, 97ft. 4½in.; mean draught, 30ft.; normal displacement, 32,000 tons. The Idaho will be propelled by Parsons four-shaft geared cruising turbines supplied by Babcock boilers. It is expected that 32,000 shaft horse-power and a speed of 21 knots will be realised. The armament is to consist of twelve 14in. 50-calibre guns, mounted in three-gun turrets on the centre-line of the ship: twenty-two 5in. 51-calibre Q.F. guns, four 3in. anti-aircraft guns, four 6-pounder Q.F., and two 21in. submerged torpedo tubes. The sides of the ship will be protected by 14in. armour up to the main deck, and armour of the same thickness will protect the funnel base. The turrets are built of plate from 18in. to 9in. thick, and the conning tower and tube are 16in. The auxiliary armament of 5in. guns is to be mounted on the upper deck, and will thus have a very high command. The absence of armour protection to these guns accords with the American principle of fitting to capital ships only such armour as will keep out the heaviest projectiles. Where armour of great thickness cannot be fitted, it is deemed better to let the enemy's shot through with as little resistance as possible. At the time of her launch the Idaho was stated to be about 70 per cent. completed. She will have a complement of 1080.

Twenty-four of the destroyers, authorised by the Act of August, 1916, and now under construction, have been given the following names:—Evans, Philip, Gridley, Taylor, Dyer, Bell, Colhoun, Ringgold, Gregory, Stevens, Kimberly, Stribling, Fairfax, McKean, Stringham, McKee, Murray, Harding, Woolsey, Wickes, Robinson, Sigourney, Israel, and Little. Five of the names commemorated are those of officers who served in the war with Spain, while the other nineteen are those of American seamen who distinguished themselves in the Civil War and earlier campaigns. The vessels are of uniform design, 310ft. between perpendiculars, 30ft. 10¼in. beam, 9ft. 1¾in. draught, with a normal displacement of 1185 tons, and the designed speed is 35 knots. They will be armed with four 4in. 50-calibre Q.F., two 1-pounder automatic anti-aircraft guns, and twelve 21in. torpedo-tubes mounted in threes. The complement will number 103.

Mr. Franklin D. Roosevelt, Assistant Secretary of the Navy, has organised a special department for requisitioning sea-going yachts for auxiliary war service. Vessels of this class are required to have a minimum length of 110ft., and to possess a reasonable degree of seaworthiness and fuel endurance. A considerable number of power yachts has already been placed at the disposal of the department by private owners on the Atlantic Coast and the Great Lakes. The Special Board for Patrol Vessels has appointed the International Mercantile Marine Company as its official agents, and this firm is accordingly attending to all such matters as the payment of subsidies and the preparation of the yachts for their new *rôle*. As the navy yards are fully occupied with other work, the company is supervising all alterations to the yachts above and below decks, and is turning them over to the navy fully armed, fitted-out, and painted in war colours. Among the well-known yachts officially mentioned as having been acquired for naval purposes are the Carola IV., Nokomis I., Emeline, Wanderer, Corona, Zara, Remlik, Sialia, and Alcedo. The system is at present on a voluntary basis, but there is a bill before Congress empowering the Government to take over all privately-owned craft of suitable dimensions for service against the enemy. Yacht owners in general, however, are exhibiting such a high sense of patriotism that the compulsory measure is expected to prove superfluous.

It is officially stated that the gunboat Dubuque, launched in 1904, with a displacement of 1085 tons and a speed of 13 knots, has been converted into a mine-layer. The cruiser Baltimore, which was similarly converted a few years ago, is serving as flagship of the mine division of the Atlantic Fleet.

So little definite information is available to the public with regard to the steps that the United States Government is taking to augment the supply of sea-going ships for the common welfare of the Allies, that we note with pleasure the publication by the Washington authorities of some most interesting facts concerning this subject. The news is communicated through the "Committee on Public Information," and it is understood that bulletins will be issued at frequent intervals, so that the American people shall be kept fully in touch with everything that is being done on their side to counteract the German submarines, so far as the production of new tonnage is concerned. The first report of the United States Shipping Board, issued on June 5th, deals principally with the enemy ships that were seized in American harbours on the declaration of war, and with the uses to which they were subsequently put. Two of these vessels, Maia and Armenia, were made ready for sea and assigned to the French Government on what is known as the "trip time charter" system. The Portonia and Nassovia were reserved for Russia, and the Clara Mennig and Pisa for Italy. Another steamer, the Ockenfels, will shortly be available for similar disposition. The following five sailing vessels, which were seized on the Pacific Coast, have received all necessary repairs, have been re-named, and are now usefully employed on charter, their present names being given in parenthesis:—Steinbeck (Northern Light), Arnoldus Vinnen (Game Cock), Kurt (Dreadnought), Dalbeck (Red Jacket), and Ottawa (Flying Cloud). Their collective tonnage is 12,514 tons gross. The steamers Staatsekretär Kraetke (2009 tons), and Governor Jaeschke (1738 tons), seized at Honolulu, were temporarily repaired and sent to Pacific yards for a more thorough overhaul. The Elsass, taken over at Pago Pago, was towed to Honolulu, and is being repaired there. Other enemy ships that were seized in the Pacific have also been brought to the coast for repairs. A later announcement states that the Ockenfels (3452 tons) has been granted to the French Government on charter, and the Ida (3093 tons), Dora (4536), Rhaetia (4141), Prinz Oskar (3777), and Magdeburg (2976), to Italy. In the course of July the following steamers were repaired and made ready for service:—Allemania (4630 tons), Pennsylvania (13,333 tons), Willehad (4761 tons), Serapis (4756 tons), Lucia (6744 tons), Clara (3932 tons), Anna (1576 tons), Prinz Joachim (4760 tons), Bohemia (8414 tons), and Erny (6515 tons), the last-named being an ex-Austrian vessel.

A considerable number of the confiscated enemy steamers have been handed over to the United States Navy, including the following, which have been re-named as shown:—Geier (Schurz), Breslau (Bridgeport), Kiel (Camden), Liebenfels (Houston), Saxonia (Savannah), Vogesen (Quincy), Nicaria (Pensacola), Odenwald (Newport News), Hohenfelde (Long Beach), Frieda Leonhardt (Astoria), Andromeda (Bath), Rudolf Blumberg (Beaufort), President (Kittery), Locksun (Gulfport). The Geier will be remembered as the German gunboat which had been interned at Honolulu since the end of 1914. Before her seizure by American officials the crew attempted to blow the vessel up, but the damage did not prove irreparable. Her new name commemorates Carl Schurz, the celebrated German-American soldier and statesman. The Liebenfels, belonging to the Hansa Line, was scuttled in Charleston harbour by her people. She was raised by military engineers and repaired at the Charleston Navy Yard. She is of 4525 gross tons, and will be employed as a collier. The average gross tonnage of the twelve other steamers enumerated above is 3360 tons.

In a further statement the Shipping Board announces the arrangements that are being made to obtain officers for the large number of new vessels which from now on will continue to be added to the American merchant fleet. Mr. Henry Howard has been appointed Director of Recruiting, with headquarters at Boston. It is estimated that there will be needed four deck officers for each ship, and four engineer officers to look after the ships building. This brings the total number of officers required up to eight thousand, while the enemy ships taken over and vessels now completing raise the actual figure to ten thousand. The work began on June 4th with the opening of a nautical school near Boston, and a gratifying number of men had already been enrolled. They are to be given an intensive course of training in the essential and practical features of navigation. As soon as pupils have mastered the theory of navigation, &c., they will be sent to continue the course on sea-going training vessels cruising between the coast of Maine and Norfolk. Fifteen such schools are to be established in the early future. Mates will receive about £50 a month, and captains £70, in addition to the war bonus. While under training the men will be paid reasonable compensation. The Shipping Board considers that in the case of men of good intelligence and some slight acquaintance with nautical matters, two months will suffice to turn them out as competent officers.

A recent bulletin by the Shipping Board states that the Emergency Fleet Corporation up to June 11th had entered into twelve contracts for emergency shipbuilding: total number of ships contracted for, 104; complete steel ships, 18; complete composite ships, 32; complete wooden ships, 30; total complete ships, 80; wooden hulls, 24.

THE GOVERNMENT AS SHIPBUILDERS.

THE announcement that the Government has taken over the shipyard which was being laid out at Chepstow by the Standard Shipbuilding and Engineering Company has come as a surprise to the shipbuilding industry, and speculations are already being indulged in regarding the position which would be created if the Government remained in permanent possession of an establishment designed for the construction of merchant ships. It is understood, however, that the occupation of the Chepstow Yard for the purposes of expediting the policy of the Shipping Controller is only for the period of the war, and the company whose undertaking has been commandeered believes that the works will ultimately return to its possession for the business of standardised shipbuilding for which the site was acquired.

In spite of the difficulties in obtaining the necessary supply of labour, as well as delivery of materials, the company has made excellent progress with the work, and two of the building slips are approaching completion, while some progress has been also made with the housing scheme, which was included in the programme of the company. Now that the yard is being completed by the Government, the somewhat comprehensive plans of the owning company, which could not have been carried out in their entirety during the war, will, in their main lines, be adopted, and, in addition to putting a large force of labour on to the completion of the shipyard and marine engineering shops, it is intended to construct at Beachley, on the opposite side of the river, a wet dock of considerable area, with an entrance from the river, which will serve as a fitting out basin. This will constitute a great improvement on the plan, which it was proposed to adopt for immediate requirements, of using the river Wye for fitting out purposes, the considerable range and force of the tide in the river rendering its use for fitting out purposes somewhat unsuitable.

The intention of the Standard Shipbuilding Company, with which important shipping interests are associated, was to construct vessels to its own standard design to meet the requirements of particular trades, but the ships to be laid down under Government auspices will probably be of the types already decided upon for the national programme. The first statement made, in connection with this development at Chepstow, referred to the intended co-operation of the Admiralty with the Standard Company in the construction of a naval dry dock but nothing appears to have been settled on this point, although it is considered by no means improbable that facilities for ship repairing will be provided.

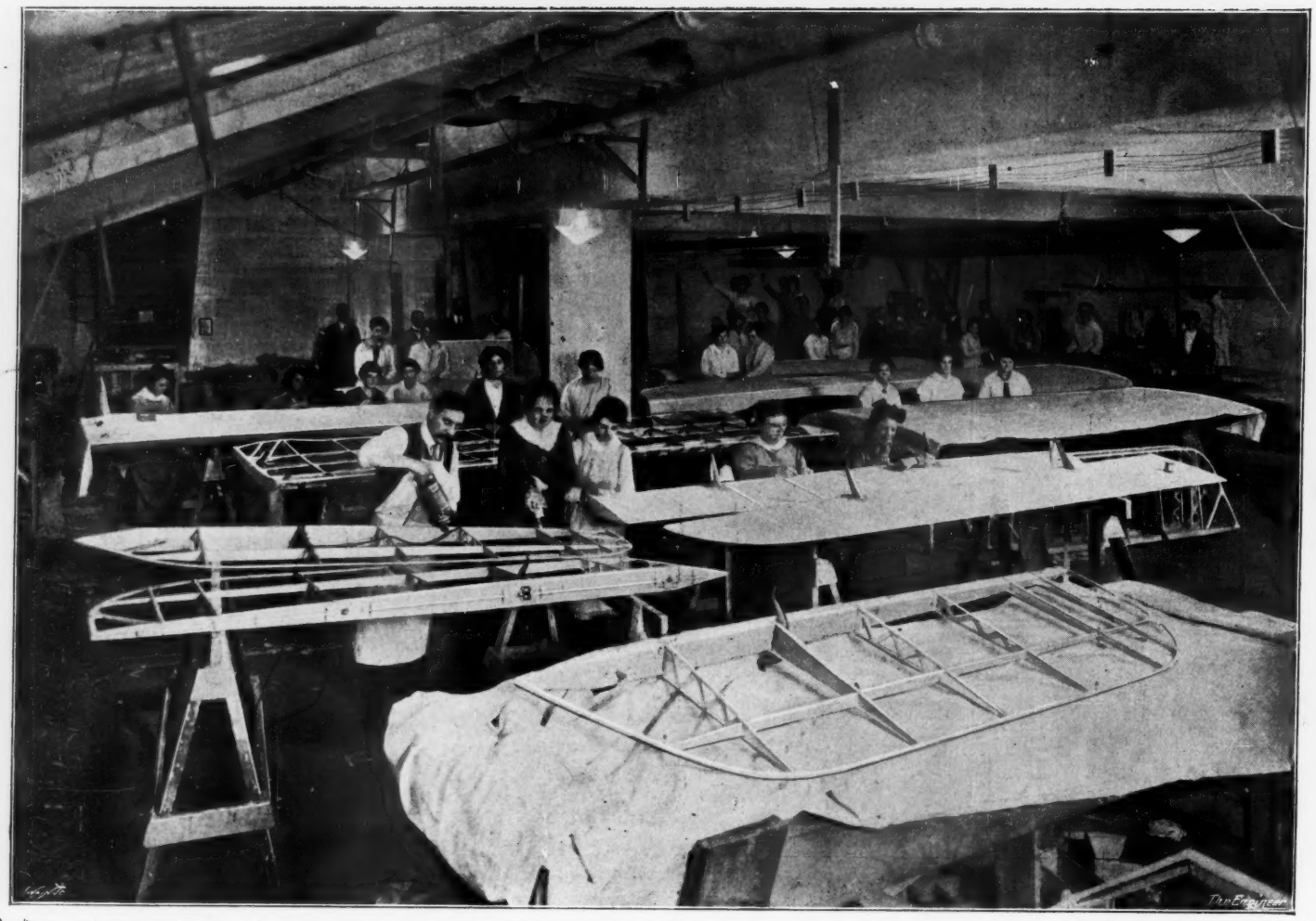
CALIFORNIA has a bad reputation for earthquakes. According to a paper read by Mr. A. H. Palmer to the Seismological Society of America, the total number of earthquakes recorded during last year is sixty-six, which exceeds the number felt throughout the rest of the United States. None of them attained a destructive intensity, and two-thirds were so slight that they were felt at one station only. They occurred more frequently near the coast than in the interior, the region of greatest frequency being that about Monterey Bay. At San Francisco there was only one very slight shock. A peculiar feature of these earthquakes is the comparative absence of the earthquake-sound, which is mentioned in only one-fifth of the records. The earthquakes are attributed generally to movements along the well-known faults which traverse the State.

[8] *International Journal of Metallography*, 1916, vol. viii., page 53.

A

AN ENGLISH AERO

BUILDING-UP WINGS ETC.



COVERING THE WINGS

ASSEMBLING WING FRAMES

BUILDING-UP WING FRAMEWORK

AN AEROPLANE WORKS.

THE visit paid by Lord Montagu a few days ago to an aeroplane works in West London is a timely reminder of the character of the national effort being made to prepare effectively for the new phase of war in the air. As the workers were reminded, the need for expediting the output of aircraft is more necessary at this juncture than at any previous period. On the preparation now made in connection with the provision of the necessary number of aeroplanes for raiding enemy territory much will depend in the concluding phases of the war. In connection with possible day raids by aeroplanes on England, Lord Montagu has received assurances which suggest that all necessary provision for defence has been made, but the only way of dealing with night raids by aeroplane is by destroying enemy aerodromes within flying distance of London and the East and South Coasts, and generally carrying the air war into enemy territory. In Germany the labour resources formerly employed in Zeppelin construction have now been diverted to aeroplane manufacture, and the training of German airmen in night flying is receiving unremitting attention. These things portend the opening of a new phase of the aerial war.

THE "SAW" MILL

What is being done at these particular factories in West London is typical of the general effort being made to meet the new enemy threat, and the illustrations which appear in this issue—see this week's Supplement—indicate the remarkable progress in manufacturing capacity which has been made in the course of a few months at the chief factory of the company. Beginning about twelve months ago with little more than a score of hands, the principal output during the early period was ammunition boxes and cases for aeroplane engines. To-day the works, which comprise sixteen shops having a superficial area of 58,000ft., employ 1000 hands, of whom about one-fourth are women workers, whose energies are devoted to the manufacture of aeroplanes and their parts. Visitors last week saw some of the latest types of Government designed machines going through the shops. In spite of the rapid development which has already taken place, important extensions to the activities of the company are now in process. The machine shop at the old works is at present somewhat crowded and by no means ideal for the metal working branch of aeroplane manufacture, and is to be transferred in the course of a few weeks to a large new factory where this section of the business will be enlarged and give employment to some hundreds of hands. It is also proposed to make considerable extensions to the propeller factory of the company. Other extensions, designed to make the business self-contained, and possibly to include the manufacture of aeroplane engines, are understood to be receiving consideration. In any case the manufacturing capacity is to be further increased to meet the demands of the Government for the needs of the war.

ORE SHIPPING PIER ON LAKE SUPERIOR.

SPECIAL features of the ports on Lake Superior, where iron ore is shipped into steamers and barges for transportation down the lakes, are the huge piers with bins into which ore is delivered from the railway wagons and from which it is spouted to the hatches of the vessels. The old piers are of timber, but steel and concrete are used for all the modern docks. The latest pier for the Duluth and Iron Range Railroad is 1368ft. long, 56ft. wide, or 74ft. over the cantilever sides of the deck, and 80ft. high from water level to the deck. Along the top run four lines of rails for the drop-bottom ore wagons. Each side of the pier has 114 bins 12ft. long, each of 350 tons capacity. The bottom has a slope of 48 deg. from the centre line of the pier's deck to an opening 7ft. square in the side of the pier. Each opening has a grate, and in front of it is hinged the long spout, operated by cable and electric winch on top of the pier, which can be lowered to deliver the ore through the ships' hatchways into the hull. The hatchways extend nearly the full width of the ship's deck, and are spaced generally 12ft. between centres. They are fitted with mechanically operated hatch covers. The base of the pier is a concrete structure about 6ft. above the water. Upon this is the steel skeleton forming the framework of the pier and ore bins. The vertical outer face and inclined bottom of each pocket are formed by concrete slabs, built in the railway yards and set in place on the steel by travelling derricks on top of the steel framework. The vertical cross walls between the bins are of concrete poured in place, and the concrete deck—with openings over the bins—was made in the same way. The pier has a storage capacity for about 80,000 tons of ore.

STANDARDISATION OF MARINE ENGINES.

THE National Committee, representing British engineering and shipbuilding institutions, the Board of Trade and the Classification Societies, to the pending formation of which reference was made in a recent issue, has now been constituted. The Institution of Naval Architects is represented by Mr. A. E. Seaton, Professor W. E. Dalby, Mr. H. Barringer, and Mr. R. Leslie. Other representatives are as follows :—Institution of Engineers and Shipbuilders in Scotland, Mr. James Brown, Mr. A. Cleghorn, Mr. J. S. Kincaid, and Mr. W. G. Weir ; North-East Coast Institution of Engineers and Shipbuilders, Mr. F. Dickinson, Mr. A. Laing, Mr. D. B. Morison, and Professor W. E. Weighton ; Institution of Marine Engineers, Mr. B. P. Fielden, Mr. T. McLellan, Mr. W. J. Vesey Lang, and Mr. A. Walker ; Liverpool Engineering Society, Mr. Willett Bruce, Mr. J. Hamilton Gibson, Mr. J. Wilkie, and Mr. S. Freeman. Lloyd's Register is represented by the Engineer-in-Chief, Mr. J. T. Milton ; the British Corporation by Mr. Rowan Thomson, who is also the Deputy Controller of Auxiliary Shipping ; and the Bureau Veritas, by Mr. J. Gravel. The Barrow district is separately represented by Mr. James McKechnie. The Board of Trade Marine Department has not yet appointed a representative, and a vacancy also exists for a representative of the Belfast district. It is understood that Mr. A. E. Seaton has undertaken the duties of Chairman, and that Mr. J. T. Milton will act as Vice-chairman.

It will be generally agreed that the Committee has been well selected, and the anticipations reflected in former references to the subject in THE ENGINEER, as to the need for securing the representation of shipowning interests and of seagoing engineers, have been fulfilled. The Committee has an opportunity of carrying out some very useful work in bringing about modifications of rules dealing with the design of marine engines and boilers which have long been in need of revision, and which have been a handicap to the British shipbuilding and marine engineering industries. No time is to be lost in getting to work, and, indeed, it is reported that questions in relation to the standardisation of marine boilers have already been under discussion, this matter, in view of conditions arising out of the war, being one of great urgency.

BOOKS RECEIVED.

The Design and Construction of Industrial Buildings. By Maurice Kahn. London : Technical Journals, Limited. 1917.

The Gold Deposits of the Rand. By C. Baring Horwood. London : Chas. Griffin and Co., Limited, Exeter-street, Strand. 1917. 15s. net.

Year Book of the Carnegie Endowment for International Peace, 1917. Headquarters of the Endowment, 2, Jackson-place, Washington-place, D.C., U.S.A.

Operation and Maintenance of Irrigation Systems. By S. T. Harding. London : Hill Publishing Co., Limited, 6 and 8, Bouverie-street, E.C. 1917. 2.50 dols.

C. M. U. A. Handbook of Approved Depôts. Compiled by F. G. Bristow. Published by The Commercial Motor Users' Association, Limited, 83, Pall Mall, S.W. 1s. 6d. net.

Hawkins' Electrical Guide—7 and 8—*With Questions and Answers.* Illustrated. Second edition. Supplied by Edwin A. Mansfield and Co., Electrical Engineers, New Brighton, Cheshire.

Registration and Publication of Directors' Names, under The Companies Act, 1917. By Herbert W. Jordan. London : Jordan and Sons, Limited, 116 and 117, Chancery-lane, W.C. 2. 1917. 6d. net.

PROVINCIAL LETTERS.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Great Call for Rolled Iron.

MAKERS of finished iron in the Midlands are kept very fully employed by the district industries, and the tonnage available for customers outside is nothing like so large as in normal times. There is hardly anything for shipment. The volume of business, as far as uncontrolled transactions go, shows no tendency to increase. Those who have anything to sell have customers waiting, and consumers coming on to the market for urgently needed supplies have to be content with small lots—often with refusals. Buyers outnumber sellers many times over. The trouble continues to be the utter inability of manufactured iron and steel producers to close with the contracts offered. The Ministry of Munitions still claims the best and almost the whole of the output of all the iron and steel mills of the district. Merchants report that the appropriation of all kinds of raw material for "A" certificate work is being more strictly enforced, the supplies available for lower classifications or for unclassified applications being now reduced to very slender proportions. Out of the total volume of trade the amount passing directly continues to grow.

Staffordshire Finished Iron Values.

Prices in Staffordshire rule very firm, and are likely to do so right up to the end of the year. Quotations for bar, strip, and hoop iron are particularly stringent. Marked bars remain at £15 10s. to £16 2s. 6d. (Lord Ward's iron), and £16 10s., less 2½ per cent.; unmarked bars, £15 5s. to £16, and on to £16 5s. net, delivered, and nut and bolt iron or its equivalent, £14 5s. to £14 10s., and £14 15s., net, delivered to consumers' district works. Tube strip is £15 10s., and hoops (steel and iron) £18 and upwards. Very many of the bars that are being sold command even higher rates than the above, being of special qualities. Makers of small rounds will book at less than £18, and there is a shortage of puddled bars at from £10 10s. to £12 per ton. A great deal of work is offered for rivet iron and material for horseshoes and rolling-stock under-frames, and also for best chain iron. Prices for special qualities are from £15 10s. to £17. Thin stamping sheets are quoted from £25 to £28, and large quantities of aircraft material are inquired for.

Black and Galvanised Sheet Trade Hesitancy.

There is little business being done in sheets. Some millowners have as much work on hand as will keep their greatly curtailed capacity employed, and there is a holding-off in other cases on account of the threatened interference by the Ministry of Munitions with the present uncontrolled prices. No new information is forthcoming relative to the intentions of the Ministry of Munitions concerning the sheet trade. It is understood, that, feeling the prices which have been privately indicated by the authorities would be ridiculous, members of the trade are persevering in their opposition, and the issue is in suspense. Galvanised sheet manufacturers are suffering from scarcity, not only of steel bars, but also of spelter. The export trade is practically nil, and as there is only the barest possible surplus for the ordinary home trade, and as the Government is buying direct from the manufacturers, the merchant is almost completely ousted. The same tendency is observable in other departments of the iron and steel trades. Sellers quote £28 10s. for galvanised corrugated sheets of 24-gauge, and £19 10s. for black sheets. As to the use of iron for sheets, as supplementary to the present steel sheet output, it is incapable of much extension, as neither scrap nor puddled iron is obtainable in any quantity.

Forge and Foundry Pig Irons.

Forge and foundry irons are in limited supply. The conditions do not give consumers the liberty of action they enjoyed a few months ago, but there is no acute shortage. Many buyers have to content themselves with transactions of reduced proportions. Smelters are in some cases refusing supplies to any but old customers. They are cautious about undertaking orders of any magnitude, having regard to their present obligations. Some large inquiries have reached South Staffordshire this week from the North of England, but they could not be entertained. Values are naturally very firm all round. An important factor in regard to foundry iron is the determination recently shown by the Ministry to substitute cast iron for brass in shell and other munition work as far as possible. On 'Change in Birmingham to-day (Thursday) for cold-blast pig iron there were inquiries at £9 for chilled castings, and strong foundry iron was quoted £8. Partmine foundry iron must be supplied mostly for the production of war goods at £5 5s., while other buyers offered £5 7s. 6d. Forge iron was in active demand at £5, and the makers said they were being "shot at" for deliveries on all sides.

New Basic Material Marketed.

The new output of Northamptonshire blast-furnaces which have been turned over to the production of basic iron, is now on offer. The full authorised price rules, viz., 97s. 6d. Some "off-iron," which has been made in the transition from the one manufacture to the other, is also obtainable. This is sold at varying prices, according to analysis. The measures taken to increase the output of basic pig are bearing fruit. Developments are imminent in Staffordshire and elsewhere which should have an appreciable effect on the situation before very long. It is reported that the Willingsworth Iron Company has started a second furnace on basic iron this week, and that at Hunsbury Hill, Northants, two furnaces which have been inactive for a long time are to be employed in this manufacture. There are two idle furnaces in the Black Country which would, no doubt, be similarly utilised but for the fact that there is no labour at hand to operate them.

Raw and Rolled Steel Conditions.

With regard to steel, the position is no easier. A strict control is established over it in all stages of manufacture, and there are practically no supplies for any but war services. The price of billets varies according to the purposes to which they are to be applied, but as much as £13 5s. and upwards is paid. In some cases they are being used instead of finished iron. Small lots of American wire rods continue to come to hand. Importers quote £27 to £29. The little relief to the market, chiefly in the shape of imported wire rods, is not growing much, and fears are entertained that as the diversion of plant in America to war production increases, the supply will stop altogether. Inquiries for semi-steel are ignored, and people who want it for rolling down have to give extravagant prices, despite the controlled rates. There are fears that the position will become worse, and it will be hopeless to expect any further orders for finished steel to be put in hand this year. Practically all the business passing in steel is for the Government, and complaints are heard that where quotations from works were submitted orders have been placed through merchants at 10 per cent. above makers' figures. Sellers of steel plates are prohibited from quoting unless they are for Ministry purposes. There are no blooms on the market, and hard discarded billets realise £11 10s. per ton. Ferro-manganese is quoted dearer, and buyers are notified that only contract deliveries can be furnished. Hematite iron is withdrawn, and customers are informed that the output of the furnaces is all allocated elsewhere. The severe stringency in steel is shown by the fact that after many years some sheet mills are reverting to the use of iron for rolling down. The demand for plates, particularly for marine purposes, is more urgent than ever. Chain, cable, and anchor makers are working at high pressure. Constructional engineers are very busy, and are inquiring for more material than is forthcoming.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron and Steel.

THE outlook for the iron and steel trades is still very obscure, and as there is no speculative element remaining in the business, it is not easy to get any guidance as to the general trend of opinion as regards the future. The political news of the week leaves the Swedish difficulty in the dark, and one cannot say yet whether the small trade between this country and Sweden in iron and steel will continue or whether it will be stopped. If we refuse to export to Sweden, no doubt our supplies of Swedish iron will be cut off. This, however, is a matter which concerns Sheffield more than Manchester. With regard to American news, it is to be noted that the fall in steel prices continues, and that American semi-steel has been quoted at £4 per ton below the highest prices previously current. Even this tremendous drop is not sufficient to bring the importation of American billets into the region of practicability. Should the prices fall still further, and freights be suitable, another hindrance to the import trade is threatened; for it is now reported that the administration of exports in America has included iron and steel in the list of prohibited articles which are not to be allowed to leave the country, unless they contribute towards actual war necessities. Hence there seems to be a very poor prospect for Manchester consumers of American steel or iron. There may, of course, be some modification of this new order; but, so far, nothing can be done in the way of arranging fresh import business.

Finished Steel.

The pressure on the steel works for all kinds of finished steel seems to increase, and merchants find it extremely difficult to obtain any for distribution to their smaller customers, who have no priority claim. The few lots of steel bars made from uncontrolled material will now bring as much as £18 10s. per ton. Shell discard bars are quoted at £16 10s.

Foundry Iron.

A larger demand for Cleveland foundry iron has been reported, but so far the supply seems to be sufficient. A new feature in this department is an increasing tendency to place larger contracts over a more extended period. This practice was, of course, quite general in the trade before the prices were controlled; but since then a great part of the business in all kinds of pig iron has been done in small lots for prompt delivery, many consumers supplying themselves by buying once a month. It may be assumed that the change in the direction of larger purchases over a longer time indicates confidence on both sides that prices will not be disturbed during the remainder of the year. The prices for the Midland foundry irons delivered in Manchester remain at 98s. 8d., including commission, for Derbyshire No. 3 and 102s. 6d. for Staffordshire. There is not much No. 1 iron offered, but an occasional lot sells at 4s. to 5s. above these prices. The demand all round is slow, and the market has a lifeless appearance; but sellers maintain that they are doing as much as they want to do, and as a confirmation of this claim, there is no sign of any competition for orders. Were this to spring up, the result would be soon apparent in the decline of the unnatural difference of nearly 4s. between Staffordshire and Derbyshire foundry iron. So long as this lasts, one may be perfectly certain that no pressure to sell exists. Scotch iron is rather scarce here, and there is a demand for all that comes into the market. This is not much, however.

Forge Iron.

Very little is heard about forge pig iron on the Manchester market now; but it is understood that the full maximum price can be obtained easily; and, in fact, provided the labour for puddling is available, forge pig at the maximum is the cheapest material available now that scrap has been advanced. There is a question whether the superabundance of Cleveland forge iron can be made use of in Lancashire, but, so far, the price is against this development.

Scrap.

There has been an improved demand all round in the market for scrap, with the single exception of ordinary heavy steel melting scrap. The latter appears to be neglected, because of the greater use now made of steel turnings. It will be remembered that in the earlier days of the war steel turnings, made in large quantities, became a veritable drug and could not be sold at any practicable price; dealers refusing to contract for them at 30s. per ton. Now there is a strong and increasing demand at 70s. per ton, and the whole production is easily sold. The heavier scrap at 105s. on trucks is evidently too dear in comparison, at any rate for those consumers who have accustomed themselves to the turnings. South Wales works still offer to take the scrap, but the price there does not leave quite 105s. on trucks here after the carriage has been paid, and hence dealers cannot get a profit out of transactions. Consumers of heavy wrought scrap are gradually giving way to necessity, and some sales have been made in Lancashire at the full maximum plus all the charges which can be legitimately added to it. This means that works have to pay from £7 7s. 6d. to £7 10s. for scrap delivered, according as they are near to or far from the yard where it lies. Business is not yet very active, because some of the consumers are waiting in the hope of getting cheaper material which has not passed through the hands of a dealer. This may happen from time to time, but, of course, the dealers will try to obtain control over all the lots coming into the market, as it is well known that there is not too much wrought scrap available. Foundry scrap has also become firmer as a consequence of smaller supplies. The dealers maintain that the rate of supply is now definitely below the rate of demand, and that the only thing which keeps prices from rising sharply is the fixed pig iron market. Meanwhile, although nominal prices for the best qualities are about the same, the demand enables sellers to get better money for the lower qualities. Very little cast scrap is now offered under 107s. 6d. per ton, and for machinery metal—apart from the best textile scrap—110s. to 112s. 6d. is asked.

Metals.

There is very little change in the prices of metals. Tin has been dearer since I last wrote, and merchants were quoting £244 for English ingots on the Manchester Exchange on Tuesday. Strong copper remains at £160. Ingot copper is not quoted, any orders received having to be sent to the Ministry of Munitions.

Engineering Education.

The technological educational institutions of this district are suffering very severely from a shortage of pupils as compared with pre-war times, but it is extremely gratifying to learn that they are managing to carry on in spite of these temporary difficulties. This is as it should be, for the ever-increasing demands of the engineering and chemical industries imposed by the war necessitate a correspondingly larger supply of the workers, which schools such as the Manchester School of Technology turn out. The prospectus of part-time courses in mechanical engineering for the session which opens on October 1st indicates that the syllabuses are generally similar to those of the session 1916–17. Special attention is directed to the apprentices' day course, comprising mechanics, heat engines, mathematics, drawing and laboratory work. This course occupies one day per week, and has not hitherto been as well attended as it certainly deserves. This is much to be regretted, for it is generally admitted that the day course provides a more satisfactory opportunity for youths of acquiring knowledge than is provided by the evening classes, and many more engineering firms in this district might with mutual advantage afford their more industrious apprentices this opportunity of improving their theoretical education. Mention should be made also of the praiseworthy policy adopted at the Manchester School of Technology in electing to the teaching staff men who combine the latest practical experience in engineering design with high technical ability, such, for example, as Messrs. Miles Walker, Stoney, and Dempster Smith. In addition to the instructional work carried on at the school, I should not omit to refer to the large amount of research and experimental work of national importance which is being conducted in electricity, chemistry, and engineering.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is really nothing fresh to note in the general condition of the hematite pig iron. On every hand there is activity at the works, and a good volume of iron is being produced, heavier per furnace than at any time in the history of the trade. In Cumberland the setback, when furnaces had to be damped down, is almost put to rights again. The plant is nearly in full swing once more, and it is hoped that a big output will be maintained for a long while to come. The demand for iron is exceedingly brisk, and from present appearances is likely to remain so for a lengthened period. The local demand for iron is alone very heavy, Barrow and Workington steel makers having huge requirements. Prices are steady at the maximum rates, with parcels of mixed numbers of Bessemer iron at 127s. 6d. per ton f.o.t., and special brands, for which there is a very keen demand outside the district, are at 140s. per ton. There has been nothing done in warrant iron of late. The stores stand at but 430 tons.

Iron Ore.

In the iron ore trade there is rather more activity, but the largely increased number of men expected to be employed has not yet become an accomplished fact, although additional men are being put on at the mines. In both Cumberland and Furness, special attention is being paid, not only to increasing the tonnage of metal raised, but to the development of existing property and the discovery of new beds of ore. The demand for foreign ores continues to be very steady.

Steel.

The steel trade is very busy at both centres, Barrow and Workington. Makers are experiencing a full and a steady demand for special sorts of steel of the semi-manufactured sort, on local as well as general home account, and the mills are keeping up a good output from every available branch. The demand is exceedingly keen. So far as finished steel is concerned, such as rails, there is only a small demand except for special delivery. There is a steady request for some sorts of shipbuilding material, such as castings, but nothing is yet being done in ship plates. Prices are steady, with heavy rails at £10 17s. 6d. to £11 per ton; light rails, £14 to £14 10s.; heavy tram rails, £14; billets, £10 7s. 6d.; ship plates, £11 10s.; and boiler plates, £12 10s. per ton. The engineering shops and shipbuilding yards are busily employed.

Fuel.

There is a keen demand for steam coal, and prices run from 25s. to 27s. 6d. per ton. Supplies are now being drawn from the Durham and Northumberland districts. House coal runs from 27s. 6d. to 37s. 6d. per ton delivered. For coke the demand continues to be steady, and East Coast sorts are at 33s. to 35s. 6d. per ton delivered. Lancashire sorts are at 31s. per ton delivered.

SHEFFIELD.

(From our own Correspondent.)

Reconstruction Problems.

RECONSTRUCTION of industry after the war has so many aspects that there seems a difficulty in arriving yet at anything more than general ideas, though attempts here and there are made to do so. This week I was discussing the question with an armament official. His firm, like others, is necessarily devoting much thought to the question of how it is to reconstruct the vast section of its business which before the war was concerned with the production of "peaceful" manufactures. It is fully recognised, of course, that when the equilibrium of Europe has been regained the demand on home and oversea account will be enormous, but the trouble appears to be to make any reliable calculation as to the particular directions in which the demand will first reveal itself, and also as to how the enormous industrial *clientele* which these large firms had prior to the war can be reorganised. In the meantime, whilst the Sheffield concerns have been working almost exclusively for the Government and our Allies, the requirements of their old customers have had to be met elsewhere. At first the smaller firms here reaped a rich harvest through sub-contracts, but very soon that field also was taken by war production, and valuable Sheffield business has trickled away to various countries, and may or may not return. The official with whom I was speaking by no means shares the optimism of many regarding conditions after the war. He considers it absolutely impossible at present to say what is to be expected. "It is all very well," he said, "to talk about beating your swords into ploughshares, and your spears into pruning-hooks, but some of the swords and spears will never be made into ploughshares and pruning-hooks, and, even if they were, who can be certain that there will be any use for them as such? Take the women now working hard in shell shops. The shells will not be wanted, and what are the women to do unless some other occupation can be found for them in steel works?"

Women's Work.

BUT one remembers the frank assurances of the chairman of Cammell Lairds, who, if I remember aright, told a large gathering of men and women war workers that when peace came the difficulty would not be to find employment for them, but to secure sufficient labour to execute all the work there will be to do. Personally, I take the view of Mr. Hichens, and believe that once the nations have recovered themselves a little the stupendous work of material restoration in every belligerent country will create a demand that it is at present almost impossible to realise adequately. Even here in England we have seen railway tracks pulled up, and locomotives and wagons sent across the Channel, whilst all rolling-stock building is three years in arrears, and train-tracks are getting into such a neglected condition that passengers are subjected to one series of jolts. And what about arrears of building—house building, I mean. Well, my point is this: Women have proved so wonderful in turning to almost anything that requires to be done, that when their services are no longer needed for shell-making—and may that time be soon—it is reasonable to believe they will be equally good workers at other jobs. Some will not require to work, their husbands having returned safely from the war; others, for the sad opposite reason, will be only too thankful to continue in the position of bread-winners. It requires no very great stretch of imagination to see that those swords and spears which are not beaten into ploughshares and pruning-hooks will still be good enough steel to convert into very useful machinery of another kind—whatever circumstances may demand. The most difficult problem refers to the relations of Capital and Labour, and I must say that here in Sheffield employers never in the past put themselves out of the way as they are now doing to improve those relations and make them permanently good. This is the more remarkable, seeing that the Ministry of Munitions controls the labour situation for the period of the war, so that the present efforts of employers must be directed to conditions which will prevail when that control has ceased to exist. It must also be said that locally most of the labour leaders are working with the same object. Most devoutly is it to be hoped that complete success will crown these efforts, for, whatever fabric may be constructed for trade after the war, the important expansions hoped for will be delayed, and even possibly prevented altogether, unless Labour works with Capital, as well as Capital with Labour. Successful reconstruction depends equally upon both, and both must realise the fact to the fullest extent.

Welfare Propaganda.

Personally, I am convinced that one of the wisest moves made is that for the improvement of the workers' conditions. For this, the men who will most certainly be

benefited have two influences to thank—the war and the women. The war made it necessary for an army of women workers to be employed, and the presence of women in the works has been responsible for what is now being done in the improvement of conditions. The conditions needed improvement in most cases. They needed it very badly in many instances. But men would have worked on, "roughing" it, and probably injuring their health in the the process. The new order should not only produce better working conditions, but better work. If it does not do the latter, then the arrangement will be one-sided, and must sooner or later break down. Dr. Ripper, the Vice-Chancellor of the Sheffield University, takes a thoroughly practical view of this question. It has been my privilege to discuss the labour problem with him on several occasions. He understands it thoroughly. Evidence of that fact, and also of his equal ability to see the employers' side of the matter, was amply revealed in the paper that he read before the Royal Society of Arts some few months ago. At that time I mentioned that such a paper should be specially adapted to the needs of Sheffield, and read before representative gatherings here. That suggestion, I am pleased to say, has been taken up, and in a few days the Vice-Chancellor will lecture before an audience of the character indicated in the Cutlers' Hall. The question of welfare work, however, apart from workshop reform and reconstruction, is being taken up by the University in a thorough and serious manner. Addressing a meeting here on Monday, Dr. Ripper said more attention was now being paid to the necessity of conserving our human resources than ever before. Industry to-day was no longer merely a mechanical process; it was looked upon as an organism, with its human element requiring care and attention. Experience in Sheffield, he added, entirely justified the welfare movement. Everybody was abundantly satisfied with the results. It had brought about a smoothness of working which could never have been secured if attention had not been turned in this direction. It had been recognised by the employers as an extremely valuable asset to them in their work, and it had been recognised by the employees as a boon. In the early days of their determination to help the country, they never expected to find that work would be carried on under such helpful conditions as it was at present. The movement, concluded Dr. Ripper, presented a great new outlook upon industry, and a great new opportunity for all those who had any means of applying its principles to industrial processes.

Round the Works.

The product of another steel furnace is just about to be added to the general output of steel for this district, the installation this time being at the works of the Sheepbridge Coal and Iron Company, the directors of which concern, by the way, have acquired agreements for leases of the Barnsley seam underlying a large area of land at Finningley, on the eastern boundary of the Rossington coalfield. The permanent plant at the latter, which is one of the Sheepbridge group, is now practically completed. The directors state that a large number of workmen's houses has been erected, and that the output of coal is gradually increasing; but sinking operations at Firbeck have not yet been begun, the delay being due to circumstances arising out of the war. One hears a great many comments upon the action of the Government in prohibiting temporarily the further erection of electric steel furnaces, except under permit. There is a "needs must," presumably, for the step would otherwise be very unfortunate at a time when it might have been expected that such developments would be most helpful. Perhaps under the new national service scheme better supplies of labour may be forthcoming, and then, if means can be found for expediting the supply of such things as electrodes, there may be a removal of the restrictions upon erection. America is going ahead with these furnaces, and the Sheffield Corporation has in view a probable very large extension of their use here in the future. The provision the Corporation is making is, as I have before mentioned, an expansion of the electricity undertaking to the tune of half a million sterling. Lack of space prevented me referring last week to the interesting discussion of this scheme at the City Council meeting. One of the members opposed it on the grounds of "unjustifiable risk," and asked how the Corporation would hold its own, selling current at $\frac{3}{4}$d. per unit, plus 20 per cent., if there were anything in the assertion made in another quarter that it was possible in that district to produce energy at a farthing per unit? The amendment proposed, however, obtained no sympathy, the Council realising that in the interests of Sheffield's industry, the larger scheme must be pushed on with. In the course of the debate, it was stated that when one consuming company first came to the Corporation, a guarantee was required that at least £1000 worth of current would be taken each year. That company's total consumption per annum now reached £100,000. To-day the Government requires large quantities of electricity, and the demands of private consumers are always increasing. The Corporation has now applications before it for 21,000 kilowatts for driving electric furnaces alone. The demand for tools and tool steel is as great as ever, and special attention seems to be directed to steel parts for automobiles. Aeroplane and magnet steel, too, are extremely active. The Government's Order suspending the use of chrome ore, except for war work, is a great disappointment to those who were endeavouring to work up a development of stainless steel. Whether or not this will rob Sheffield of the splendid start it possessed, the new steel having been discovered here, remains to be seen.

Iron, Steel, and Coal.

The iron and steel markets, locally, continue with very little change to record, forge and foundry iron being still limited in supplies in consequence of the greater attention given to the production of basic pig. A fair share of the special qualities of hematite iron appears to be coming here, but manufacturers could do with much more. Makers of high-speed steel, too, would like to see deliveries of tungsten powder quickened. With the limited quantity available, bar iron is in very full demand. There is still Swedish material to be obtained, though at a ridiculously high figure—something approaching £70 delivered. Scrap of all kinds in steel is in active request, with borings and turnings much wanted, but a feeling of dissatisfaction with the new wrought iron scrap prices seems to prevail, appreciably restricting business. The demand for all classes of steam coal continues very strong for inland consumption, and exports to Allies are active, whilst the Government is taking large quantities at port. Slacks are going away freely. The position of house coals is unchanged. Best South Yorkshire steam hards are quoted 17s. 6d. to 18s.; best Derbyshire, 16s. 9d. to 17s.; seconds, 16s. 6d. to 16s. 9d.; nuts, 16s. 6d. to 17s.; best hard slacks, 12s. 3d. to 12s. 9d.; seconds, 11s. 9d. to 12s. 3d.; soft nutty, 12s. to 12s. 3d.; peas, 10s. to 10s. 6d.; and small slacks, 6s. to 6s. 6d. In house qualities, branch is quoted 21s. to 21s. 6d., and best Silkstone 18s. to 18s. 6d., all per ton at pit.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

HOME consumers having almost completely covered their requirements under the September allocations, the Cleveland iron market is now somewhat quiet, though the tone is quite firm. This month has seen a marked expansion in the demand for iron from home consumers, particularly in the North of England. Allocations were on a very liberal scale, and this was fortunate, inasmuch as transport conditions, both as regards the railways and labour at the works, leave a good deal to be desired. The lack of trucks is causing a considerable delay in deliveries, and the result will be that at the end of September there will probably be a large volume of arrears which will have to be cancelled. This will involve larger applications for October. While there is no accumulation of stocks, foundry iron continues to be in good supply. Forge iron is also plentiful, but some substantial sales of this quality have been made for deliveries up till the end of the year. Scottish consumers, in particular, are taking up larger quantities of forge iron for bar making. Another furnace to produce Cleveland pig iron has been put into operation at the Cargo Fleet Ironworks. An additional furnace has also been put into blast on hematite. The total number of furnaces now in operation in the North of England is now seventy-six. The demand from abroad is very heavy, but business is strictly limited to the export of iron to France and Italy. Prices are unchanged, the maximum quotation for home consumption being 92s. 6d. for No. 3, No. 4 foundry and No. 4 forge, with a premium of 4s. for No. 1. The export quotations are:—No. 1, 107s. 6d.; No. 3, 102s. 6d.; No. 4 foundry, 101s. 6d.; and No. 4 forge, 100s. 6d.

Hematite Pig Iron.

The stringency in the East Coast hematite trade is absolutely unabated, and home consumers absorb such a large proportion of the output that there is little available for shipment abroad. Fortunately, supplies will soon be augmented, Gjers, Mills and Co. having put another furnace into operation at their Ayresome works for the production of hematite. Home consumers are kept going literally from hand to mouth, and home needs, of course, must necessarily be the first care. It is understood that makers are pressing on with arrangements to utilise native ores in the production of basic steel, but such a big change in production is not accomplished in a day, and, in the meantime, the pressure for deliveries of East Coast hematite is as strong as ever. A few shipments are being made under old licences; but new business is entirely held up pending some action on the part of the authorities in regard to licences. Possibly they will, simultaneously with the issue of licences, make some announcement on the subject of the export price; but in the meantime, subject to official sanction, export business in East Coast mixed numbers is being done at 141s. per ton, plus the excess ore freight, whilst home consumers are obtaining their supplies at 122s. 6d. per ton.

Iron-making Materials.

There is no new feature in the foreign ore trade. New business is quiet, but deliveries are coming to hand under existing contracts fairly satisfactorily. Coke is plentiful, but prices are firmly maintained, good medium furnace qualities realising 30s. 6d. delivered at the works.

Manufactured Iron and Steel.

There is no material change to report this week in the conditions prevailing in the manufactured iron and steel trades. All departments keep very active, many to a degree never before experienced or approached. War requirements, of course, continue to dominate the situation, and manufacturers have practically nothing available for ordinary commercial needs. Very great efforts are being made to expedite the output of shipyard steel, the demand for which is intense. Exports are very strictly controlled, permits only being issued for limited quantities of certain descriptions to the Allies and Dominions. The principal quotations for home trading are as follows:—Steel ship plates, £11 10s.; steel boiler plates, £12 10s.; steel ship angles, £11 2s. 6d.; steel joists, £11 2s. 6d.; heavy steel rails, £10 17s. 6d.; common iron bars, £13 15s.; best bars, £14 5s.; double best bars, £14 12s. 6d. The following are nominal quotations for export:—Common iron bars, £15; best bars, £15 5s.; double best bars, £15 12s. 6d.; treble best bars, £16; packing iron, £13 10s.; packing iron, tapered, £15 15s.; iron ship angles, £15; iron ship rivets, £18 10s.; steel bars, basic, £16 10s. to £17 10s.; steel bars, Siemens, £16 10s. to £17 10s.; steel ship plates, $\frac{3}{8}$in. and upwards, £13 10s.; $\frac{5}{16}$in., £13 15s.; $\frac{1}{4}$in., £14; $\frac{3}{16}$in., £16; $\frac{1}{8}$in., £18; steel boiler plates, 20s. on the foregoing prices; steel joists, £11 2s. 6d.; steel sheets, singles, £20; steel sheets, doubles, £22; steel hoops, £17; heavy sections of steel rails, £12, all less 2$\frac{1}{2}$ per cent., except ship plates, angles and joists, packing iron and iron bars.

Scrap.

So far the revision of the maximum prices in the scrap trade has not brought much material on to the market. Considerable dissatisfaction still prevails regarding the prices of wrought iron scrap, and the general opinion is that the advantages gained by the changes are more than counterbalanced by the disadvantages. The fixing of a single maximum price for all grades of wrought iron scrap, the values of which vary in normal times to the extent of more than 20s. per ton, does not please everybody. The best quality is worth more than the price fixed, and the lower qualities are not worth nearly as much. Of course, buyers need not pay the maximum price if the material is not worth it. Another sore point with buyers is that of the extra 7s. 6d. which is allowed for making the scrap ready for rolling, and they declare emphatically that they will make no new contracts if the extra is demanded. Merchants, however, are adamant on the point. Consequently business in this important section continues very difficult to transact. Supplies of steel scrap of all descriptions are reported to be coming forward more freely. The new proviso that steel scrap to guaranteed analysis can now only be sold with a permit has removed what was a big loophole for securing prices above the maximum, and it was a sore point with the more conscientious firms that others were getting an unfair advantage in this way. The principal quotations are: Wrought iron scrap, £6 5s.; wrought iron scrap mixed with steel or other materials, £2 10s.; second-hand rails, £10; heavy steel melting scrap, without guaranteed analysis, £5 5s.; steel turnings and borings mixed with wrought iron or other material, £2 10s.; all other classes, heavy or light, £5 5s.; heavy steel melting scrap, with guaranteed analysis, not over 0.04 per cent. phosphorus and sulphur, £6 5s.; not over 0.05 per cent., £6.

The Coal Trade.

There is no alteration of importance in the northern coal trade. New business continues very slack all round. The new coal transport scheme is now in operation, but it is too early yet to judge of its effects on the working of the collieries. At the moment the positions of the various collieries are anything but uniform; but this state of affairs cannot be put down to the new scheme. The Northumberland pits are favourably situated, but the Durham pits are irregularly placed. Many of them are losing time on a considerable scale, while the outlook is by no means cheerful. A good many exporters, it is stated, have had large quantities of arrears on contracts entered into prior to May 1st cancelled during the past few days, and it would appear as though the Coal Controller would not allow much latitude in these cases. The most interesting feature of the week is the fact that the Norwegian State Railways have entered the market for their November supplies of best steams, which are again 18,000 tons, to be delivered as required during November and December. The tenders are due to be returned during the next few days, and the result is awaited with considerable interest. There is only a moderate inquiry for spot supplies, these being mainly for odd lots of best steams. Otherwise there is only a poor show. The loadings which are going forward are chiefly on account of the Admiralty and other national and Allied services, which, together with contract loadings, account for all that is passing at the moment. In the Northumberland section best steams continue very brisk, and are practically the only satisfactory feature of the market. The position in regard to smalls is very unsatisfactory. The demand has fallen to a very low level, and collieries are experiencing great difficulty in keeping stocks within reasonable limits. The Durham section is practically unchanged, export business still being very quiet. The principal quotations are as follows: Northumberlands: Best Blyth steams, 30s.; second Blyth steams, 25s. 6d. to 27s. 6d.; North Northumberland prime steams, 28s.; unscreened for bunkers, 24s. to 25s.; household coal, 20s. to 21s. for home trade, 28s. 6d. to 30s. for export; best Blyth smalls, 20s.; best Tyne smalls, 18s. 6d. to 20s. Durhams: Steam (locomotive), 28s. 6d. to 30s.; special Wear gas, 28s. 6d. to 30s.; best gas, 25s.; second gas, 22s. 6d.; ordinary bunkers, 24s.; smithies, 26s. 6d. to 30s.; peas and nuts, 24s. 6d. to 30s.; coking coals, 25s.; foundry coke, 42s. 6d.; patent coke, 42s. 6d.; furnace coke, 28s.; gashouse coke, 30s. to 31s.

SCOTLAND.

(From our own Correspondent.)

Pig Iron.

SCOTCH pig iron makers have a steady demand for all qualities. Local steel works easily absorb the production of hematite, and outputs are hardly sufficient to meet requirements. Forge and foundry qualities are quickly disposed of in view of the restricted supplies available. Generally speaking, home users are receiving fair deliveries, but nothing is being done in exports apart from Allied orders. Prices are firm and unchanged.

Quotations.

Monkland and Carnbroe are quoted f.a.s. at Glasgow, Nos. 1, 125s.; Nos. 3, 120s.; Govan, No. 1, 122s. 6d.; No. 3, 120s.; Clyde, Summerlee, Calder and Langloan, Nos. 1, 130s.; Nos. 3, 125s.; Gartsherrie, No. 1, 131s. 6d.; No. 3, 126s. 6d.; Glengarnock, at Ardrossan, No. 1, 130s.; No. 3, 125s.; Eglinton, at Ardrossan or Troon, No. 1, 126s. 6d.; No. 3, 121s. 6d.; Shotts and Carron, at Ayr, Nos. 1, 130s.; Nos. 3, 125s. per ton.

Finished Iron and Steel.

The situation in the Scotch finished iron and steel trades continues one of exceptional activity. All branches are constantly employed and makers' order books will keep things moving for months to come. At the steel works work of national importance absorbs all the time, and general mercantile business scarcely receives any attention. Black steel sheet makers are in a similar position, and though ordinary consumers are prepared to pay fabulous prices for supplies, works are not in a position to accept many of these orders. Common black sheets are quoted at £18 5s. per ton f.o.b. Glasgow. Prevailing conditions in the malleable iron trade are indicated by the large increase in the use of shell discard material in place of "Crown" and other quality iron bars, which are now seldom obtainable, in view of the fact that the

majority of the mills are now engaged in the production of steel. The various departments of the engineering trade are fully employed, chiefly on war work.

Coal.

The Scotch coal trade does not present any fresh feature. The new division-of-districts scheme is now in operation, but in view of the readjustments necessary to meet the altered conditions, it is impossible as yet to venture an opinion as to the ultimate effect on business. In the West of Scotland district during the past week a steady turnover has been maintained in the industrial and household qualities, but the tone continues quiet. Ell coals are quoted, f.o.b. at Glasgow, 26s. 6d. to 28s.; splint, 28s. to 30s.; navigation, 30s.; steams, 27s. 6d.; treble nuts, 23s.; doubles, 22s.; singles, 21s. per ton. The situation in the Lothians is hardly satisfactory. An improvement in the amount of employment is reported, however, fully 80 per cent. of the miners in the Mid and West Lothian collieries having obtained nine to ten days' work during the last fortnight. Orders are more plentiful, and prospects for the winter trade are more hopeful. Best steams are quoted, f.o.b. at Leith, 26s. 6d.; secondary qualities, 25s. 6d. per ton. The position in the Fifeshire district still gives cause for anxiety. A great deal of idle time is experienced and considerable quantities of fuel have been put on the bing. Business is dull all round, but more particularly in the export department. First-class screened navigation coal is quoted, f.o.b. at Methil or Burntisland, 29s. to 31s.; first-class steams, 28s.; third-class steams, 24s. per ton. The aggregate shipments from Scottish ports during the past week amounted to 163,383 tons, compared with 156,982 in the preceding week, and 227,671 tons in the corresponding week of last year.

Strike Averted.

The strike of the Scottish colliery enginemen, which would have thrown 100,000 men idle, has been averted. The Coal Controller has offered the men a war bonus of 1s. 3d. per shift, and this has been accepted.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Cardiff Coal Trade.

THE coal trade at the present time cannot be described as being in a very satisfactory state, but a serious effort is to be made to put an end, as far as possible, to unauthorised stoppages of work in the coalfield. Attention was drawn at a recent meeting of the Conciliation Board to the fact that since July 23rd last there have been no less than thirty stoppages without notice. Mr. F. L. Davis, speaking on behalf of the employers' representatives, stated that the owners would be quite prepared favourably to consider any suggestion from the workmen's representatives whereby such suspensions of work could be avoided, and that a method should be devised if necessary for expediting the inquiries into disputes. The workmen's representatives were at one with the owners that strikes without notice should not take place. The upshot of the discussion was that the joint secretaries should be empowered at once to appoint representatives to inquire into any questions in dispute that may arise, and these representatives are to have power to settle. They are also to be authorised to call in the assistance of the joint emergency committee if necessary.

South Wales Steel Workers.

The case of the steel workers for fixing one o'clock Saturdays as the time for finishing instead of 4 or 5 o'clock was put forward by their representatives at a meeting of the Wages Board of the South Wales and Monmouthshire Iron and Steel Workers Association at Abergavenny on Saturday last. The employers, however, decided that they could not accede to the men's suggestion, having in view the appeals of the Government for an increased output, but they promised to give an undertaking that the matter should receive immediate consideration after the war. The position will therefore be laid before the workers. Consideration was also given to the report concerning the joint audit of accounts for the past month, but as no variation in the selling prices of tin bars and steel rails was disclosed, the wages of the men consequently will remain unaltered, the percentage being 89½.

Miners and Income-tax.

The Executive Council of the South Wales Miners' Federation has considered the report of the members of the Committee of the Miners' Federation of Great Britain who waited on the Chancellor of the Exchequer relative to the levying of income tax on wages. The reply of the Chancellor was considered unsatisfactory, and it was decided that he should be asked to meet a deputation of the South Wales Miners' Council. Mr. Ashton, the secretary of the Miners' Federation of Great Britain, is also to be requested to place the matter on the agenda of a conference on the wages question to be held in London on the 26th inst.

Current Business.

Operations on the coal market have been of a very restricted character, and with the majority of exporters the past week has been a period of marking time. The demand for coals for inland purposes has been very heavy, but arrangements in connection with the Coal Transport Reorganisation Scheme are a long way from being settled. It requires experience and knowledge of its working to improve the machinery, and doubtless, in course of time, much smoother conditions will be evolved. It has been seen that a mistake was made in allocating orders for dry coals for home consumption, and consequently these have been withdrawn and are being substituted by Monmouthshires, which are of a more bituminous character. Furthermore, collieries which were ordered to send bituminous coals to the South-Western counties have had their instructions cancelled, as coals from Derbyshire and Notts are to be directed there. Naturally these alterations have upset arrangements considerably. In some cases the collieries had commenced delivery. So far there is no news concerning the new classification list, and consequently prices of coals remain unaltered. Smalls particularly are in abundant supply. Coke is about the firmest spot in the market, there being a good demand from France as well as for home consumption. Patent fuel makers are in a slightly better position than last week, and values are about 30s. to 32s. 6d. Supplies of pitwood are coming along slowly, and although the demand is not so active, importers are seeking to improve upon the prices of 60s. to 61s.

Schedule Quotations.

Steam coal: Best Admiralty large, 33s.; best seconds, 31s. 6d.; seconds, 30s. 9d.; ordinaries, 30s.; best drys, 30s.; ordinary drys, 28s. 6d.; best bunker smalls, 23s.; best ordinaries, 21s. 6d.; cargo smalls, 20s.; inferiors, 18s.; washed smalls, 22s. 6d.; unwashed duff, 14s. to 18s.; best Monmouthshire Black Vein large, 30s.; ordinary Western Valleys, 29s.; best Western Valleys, 29s.; seconds Western Valleys, 28s. Bituminous coal: Best households, 33s.; good households, 30s. 9d.; No. 3 Rhondda large, 30s. 9d.; smalls, 26s.; No. 2 Rhondda large, 27s.; through, 25s.; smalls, 20s.; best washed nuts, 30s.; seconds, 28s. 6d.; best washed peas and beans, 27s. 6d.; seconds, 26s. 6d.; patent fuel, 30s. to 32s. 6d.; coke, 47s. 6d.; pitwood, ex ship, 60s. to 61s.

LATER.

The coal market conditions display no appreciable change, and irregularity is the chief feature of work in the coalfields. Schedule prices remain unaltered. Patent fuel is quiet, the quotation being generally 30s.

Newport.

There has been no noticeable improvement in the Monmouthshire section of the coal trade during the past week. Prompt orders have been particularly scarce, and many collieries have experienced difficulty in carrying on. Stocks of smalls have been very heavy, and the demand being very slow, collieries have been hampered in clearing wagons. Schedule prices:—Steam coal: Best Newport Black Vein large, 30s.; Western Valleys, 29s.; best Eastern Valleys, 29s.; other sorts, 28s.; best smalls, 20s.; seconds, 18s. Bituminous coals: Best house, 33s.; seconds, 30s. 9d.; patent fuel, 30s. to 32s. 6d.; pitwood, ex ship, 60s. to 61s.

Swansea.

The anthracite coal trade has relatively been in a fairly good position. A good demand has been experienced for large descriptions, particularly the better grades, and exporters have had considerable difficulty in obtaining their requirements. Machine-made descriptions have been quite strong and beans and nuts have ruled scarce, but cobbles have met with a slow inquiry, while rubbly culm and duff have been especially quiet. Schedule prices:—Anthracite: Best malting large, 30s.; second malting large, 29s.; third malting large, 27s. 6d.; Red Vein large, 25s. 6d.; machine-made cobbles, 39s. to 42s. 6d.; French nuts, 39s. to 42s. 6d.; stove nuts, 39s. to 42s. 6d.; beans, 33s. to 35s.; machine-made large peas, 20s.; rubbly culm, 13s.; duff, 6s. 6d. to 8s. Steam coal: Best large, 30s.; seconds, 27s.; bunkers, through, 23s. 6d.; smalls, 17s. Bituminous coal: No. 3 Rhondda large, 27s.; smalls, 24s. Patent fuel, 30s.

Shipbuilding Developments in South Wales.

Developments in the Chepstow area are proceeding apace, and indications are not lacking that in the future this district will become a centre of intense industrial activity. Already the vicinity of the town is rapidly undergoing transformation, and considerable interest is being aroused throughout South Wales in the scheme which is in hand for making this an extremely important centre for shipbuilding and ship repairing. At the present time it is impossible fully to appreciate the effects which impending developments in this area will have upon allied industries, which are calculated to benefit the South Wales district. Efforts are being made at all the leading South Wales ports to secure a share in the increased industrial activity that is likely to take place. So far nothing tangible has come of the scheme for shipbuilding at Cardiff, but it is reported that negotiations are proceeding satisfactorily for the acquisition of land at the old South Wales and Risca wharves near the Town dock at Newport. The scheme for the construction of a large dry dock at the King's Dock, Swansea, has also been revived, and it is reported that a firm with considerable interests in the port, but whose principal interests are in the North of England, is negotiating with the Harbour Trust. It is understood that the construction of the proposed dry dock, which will accommodate the largest vessels afloat, will not be begun until the war is over.

Tin-plates.

The tin-plate trade shows pronounced firmness, and makers are reluctant to book fresh orders in view of their present commitments. Supplies of steel bars continue to be very restricted, though mills have been able to work a little better lately. Quotations: I.C., 20 × 14 × 112 sheets, 108 lb., 30s.; block tin, £242 5s. per ton cash; £242 10s. per ton three months; copper, £120 per ton cash; £119 10s. per ton three months. Lead: Spanish, £30 10s. per ton.

ELECTROLYTIC CORROSION OF METAL IN SEA WATER.

CONSIDERABLE trouble has been experienced at the Panama Canal with corrosion of lock gates and machinery due to electrolytic action set up between the iron and steel parts, and such adjacent negative metals as copper, bronze, and babbitt metal. Steel castings or valves at the Gatun and Miraflores locks, which came in contact with a babbitt metal seal on the bottom of the valve, have been rapidly eaten away. At the Pacific locks a number of the valves were in such condition that the bottom seat had to be planed away in order to make the valves tight. To protect the valves from further electrolytic action between the cast steel and the babbitt metal, the latter was removed entirely and replaced with greenheart timber. The top seats of the valves are of cast steel, held in place by bronze bolts. Corrosion has been excessive around the heads of the bolts, to such an extent that some of the bolts had fallen out. Several castings had to be replaced. In the roller trains which carry the lock gates there has been considerable corrosion of the tool-steel rollers. Some of the rollers, bolts, and filler castings had dropped out, due to this injury. In the repairs the bolts were riveted over to secure them in place. To protect the rollers small pipes were led to the bottom of the roller-path, so that crude oil can be discharged. It is expected that the oil will rise and collect upon the rollers, thus insulating them against attack. The lock gates suffered in the same way, and after repairs had been made they were painted with a bitumastic composition, claimed to resist any corrosive action and to protect the steel for a period of five years. Cast iron parts also have been eaten away.

CATALOGUES.

KAYE AND CO., Limited, Southam Works, Rugby.—This firm has sent us an interesting booklet entitled "Kaye's Portland Cement." It contains some useful particulars regarding the mixing and application of concrete, both plain and reinforced, and a description of the process of manufacture of cement at the company's works. There are also an extract from the British Standard Specification, an analysis of Kaye's cement, and various tables giving the results of tests carried out on that material.

ROBEY AND CO., Limited, Lincoln.—Two handsomely printed catalogues, one dealing with air compressors, and the other with the Robey patented Uniflow steam engine, have been received from this firm. In each case the illustrations are numerous and good, and the descriptive matter is clear and detailed. Both catalogues conclude with tables of statistical and numerical information and data likely to prove of direct use to those having to do with air compressors and steam engines respectively.

GEORGE ELLISON, Wellhead-lane Works, Perry Barr, Birmingham.—List No. 431. Illustrated catalogue dealing with electric cable fittings, pipe flanges, sealing and dividing boxes, armour clamps and glands for ironclad switchgear. List No. 151. Illustrated descriptive pamphlet, dealing with totally enclosed industrial unit-type switchgear for continuous and alternating circuits up to 1000 kilowatts at 750 volts for factories and mines; and List No. 304, illustrated descriptive pamphlet, dealing with totally enclosed, self-resetting, limit and emergency switches for cranes, hoists, lifts, or for signalling purposes.

WEBSTER AND BENNETT, Limited, Coventry.—Profiling and Cam Milling. This is a little treatise, as well illustrated as it is written, on the use of the W. and B. horizontal duplex profile milling machine. Its object is to show that a great variety of work can be done at small expense on the machine described, and that so easy is the production of master cams from samples or patterns that it pays to make them, even when only a few parts have to be machined. The illustration shows very clearly all the parts of the machine and elucidate the method of operation. Examples of special fixtures are also described. Managers who have profile milling to do will be interested in the little volume, and will be glad to learn that copies will be sent to them on application to Webster and Bennett, Limited.

BRITISH THOMSON-HOUSTON COMPANY, Limited, Rugby.—Descriptive List No. 3313 is devoted to "Truck Type Ironclad Switchgear." With the increasing adoption of H.T. and E.H.T. power supply for industrial purposes and for distribution to substations, the importance of safety, reliability and accessibility in connection with switchgear is receiving general recognition. In both classes of service continuity of supply is of the first importance. Extensions and alterations shoul be possible with a minimum of interruption to the supply, and, in industrial concerns particularly, the switchgear should be designed so that it can be handled with safety by unskilled attendants. The Ironclad Truck Type switchgear has been specially developed for such service. The complete equipment is mounted on a truck which can be withdrawn without disconnecting bus-bars or isolating switches. All H.T. bus-bars and cable connections are carried on substantial porcelain insulators mounted in frame castings, which are built up to form a complete cell structure. The framework is so designed that a new panel can be added at any time, the complete structure being finished off by cover plates bolted to the ends of the bus-bar chamber.

FORTHCOMING ENGAGEMENTS.

TUESDAY, SEPTEMBER 25TH.

ASSOCIATION OF SUPERVISING ELECTRICIANS.—St. Bride's Institute, Bride-lane, Ludgate-circus, E.C. Presidential address by Mr. J. S. Highfield. 7.15 p.m.

THURSDAY, SEPTEMBER 27TH.

ASSOCIATION OF RAILWAY COMPANIES' SIGNAL SUPERINTENDENTS AND SIGNAL ENGINEERS.—Railway Clearing House, London. Fifty-fifth Conference.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Caxton Hall, Westminster. Paper: "Standard Locomotives for British Railways," by Mr. J. F. Gairns. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE hear with regret of the death of Mr. Thomas Mitchell, senior, on the 16th inst. Mr. Mitchell was in the 76th year of his age, and was till a few years ago senior partner in the firm of Thomas Mitchell and Sons, Limited, of Bolton. The business will be carried on by his sons.

WITH a view to centralising their business in London, the Stanton Ironworks Company, Limited, is removing its office on October 1st, from 44, Coal Exchange, E.C. 3, to Maxwell House, Arundel-street, Strand, W.C. 2. Its new telegraphic address will be "Cobbles Eastrand London," and the telephone number Central 6808. Mr. Arnold Longden, who has represented the company for some years on the London Coal Exchange, will continue to supervise the company's interests at Maxwell House.

WE have received from Mr. J. A. Burns, of 170, Hope-street, Glasgow, a copy of the second edition of his little pamphlet entitled "Useful Engineers' Constants for the Slide Rule and how they are Obtained." The first edition appeared in 1903. It is a useful little publication that will be appreciated by engineers who use slide rules. Presupposing a working acquaintance with the instrument, the author gives lucid instructions how it is to be used for the shortening of certain calculations. The price is one shilling net.

SOUTH AFRICAN RAILWAYS AND HARBOURS.

THE annual report on South African Railways and Harbours gives information with regard to harbour schemes now in progress or projected. At Table Bay Harbour the reconstruction of No. 2 jetty has been completed, and four lines of rails laid. The jetty is 640ft. long and 80ft. wide, and is to be equipped with four 4-ton electric cranes and four 3-ton cranes, of which the first-named are in position.

The completion of this work provides two deep water berths, with 35ft. alongside at low water of spring tides. It was originally intended to carry out a similar reconstruction of No. 3 jetty, but this jetty has now been demolished to provide space for a new cross berth, 600ft. in length, and although the number of deep water berths has been somewhat reduced by this arrangement, the facilities for berthing have been improved. At Durban the reclamation of Congella has been proceeded with, and an additional 38½ acres of new area reclaimed during the year.

The construction of a fishing harbour at Kalk, at a cost of £63,000, is still in progress, but an additional length of 220ft. of breakwater has still to be completed. The total length of breakwater will be 782ft. At Walvis Bay a considerable change has taken place in comparison with the primitive conditions which existed at the outbreak of hostilities in South-West Africa. A 205ft. wooden jetty has been erected and fitted with a 5-ton crane; a second wooden jetty, 199ft. long, has been completed and provided with chutes suitable for the loading of copper ore; an older wooden jetty, 656ft. long, has been extended and strengthened, and equipped with two 3-ton cranes; a shed capable of accommodating 600 tons of general cargo has been erected, and a platform provided capable of storing an additional 500 tons, while buildings have been allocated as railway stores, ground set apart as a material yard, and the station accommodation improved.

The railway section of the report refers to an interesting locomotive development. In view of the recognition that higher steam pressures are desirable and that such high pressures can be raised and maintained by means of "tube or pipe generators," an attempt is being made to apply such generators to locomotive practice. A generator of this type has been designed by Mr. F. R. Collins, the mechanical superintendent, the details of which are stated to involve a radical departure from present practice, such as to require careful investigation. In the experimental stage oil fuel may be used, but the object sought is to design an engine to burn coal-dust as fuel.

Reference is made to the very satisfactory results achieved in American practice by locomotives arranged to burn pulverised fuel. Experience has shown that these locomotives have good steaming capacity on such fuel. On the United States railways the experimental stage with such locomotives has now been passed, and the practice is being extended as rapidly as possible. It is pointed out that in addition to eliminating sparks and the liability to fire grass, the locomotive working on pulverised fuel requires less time to raise steam than other types, and that the stand-by losses are considerably reduced.

AMERICAN SHIPBUILDING DEVELOPMENTS.

THE reports which have appeared in the American Press on new shipbuilding developments indicate that comprehensive plans have been prepared for large scale production. It is announced that the Federal Shipbuilding Company, which is being backed by the United States Steel Corporation, cherishes the ambition of possessing the largest shipbuilding plant in the world. It is stated that provision will be made at the Hackensack Meadows at the outset for ten slipways from 450ft. to 500ft. in length, and that at a later date slips will be provided for the construction of ships rivalling the largest now afloat or in contemplation. It is the intention of the company to make the establishment as far as possible self-contained, and a large area of land has been acquired for the marine and general engineering shops, and the power-house. The contract for dredging, excavating, pile-driving, and construction of slipways has been already let, as well as that for the buildings and the steel work, and it is hoped it will be possible to lay down two keels before the end of the present year. The fitting out basin has been designed on a scale to permit the simultaneous completion of five or six ships. Those who have had an opportunity of inspecting the plans report that the best shipbuilding practice is to be followed. At the outset, cargo boats of 9000 tons deadweight will be the standard size of ship. It is hoped to launch the first two ships in April next, and to have them ready for service by June, and, thereafter, to contribute one finished ship a month to the American mercantile marine. Although no formal contract has yet been made public, it is generally believed that all the ships built during the first two years after the yard is in operation will be on Government account.

It is reported in the *Wall-street Journal* that the shipbuilding plant to be constructed by the Steel Corporation interests at Mobile, Ala., as a subsidiary of the Tennessee Coal, Iron and Railroad Company, will also have ten slipways, but it will not be quite so self-contained a plant as that which is now being constructed near Newark, and that considerably more time will elapse before this yard will be ready for laying down the keels of cargo boats.

A NEW layer of nickel-copper ore said to be 80ft. thick is reported to have been discovered in the Murray mine near Sudbury, Ontario, Canada. It is estimated, according to the *Ironmonger*, that this discovery will raise the output of the mine from 11 million to 16 million tons a year. The mine is the joint property of the Kristianssand Nickel Refining Company, of Norway, and the British-American Nickel Corporation, the Norwegian concern having become a shareholder a couple of months ago to the extent of one million dollars of ordinary stock, while the British Government owns 14½ million dollars, and 4½ millions are held in Canada. Two years hence the company expects to be producing 6000 tons of refined nickel yearly. The British Government will have the first call on the output, while any surplus will be sold under its control.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

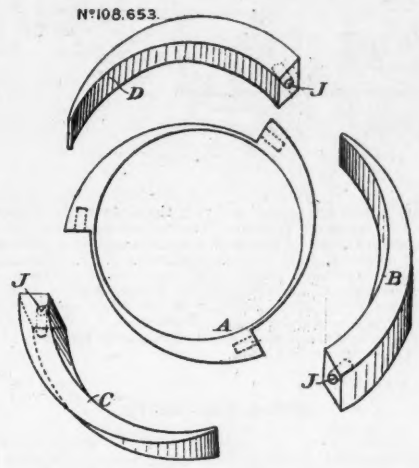
Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 6d. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM ENGINES.

108,653 (4968 of 1917). April 10th, 1917.—PISTON PACKING RINGS, *Hutsons, Limited*, 130, *Kelvinhaugh-street, Glasgow* (a communication from Henry McClenahan, 36, Lisburn-road, Aigburth, Liverpool, at present sailing on s.s. Maidau).

This invention relates to improvements in piston rings and rod packings, and has for its object to provide a packing ring which will automatically adjust itself to the cylinder. There is provided a ring A of cast iron, brass, or other suitable metal, having formed on the outside edge thereof two or more wedge-shaped pieces. Round the outside of this ring there is another

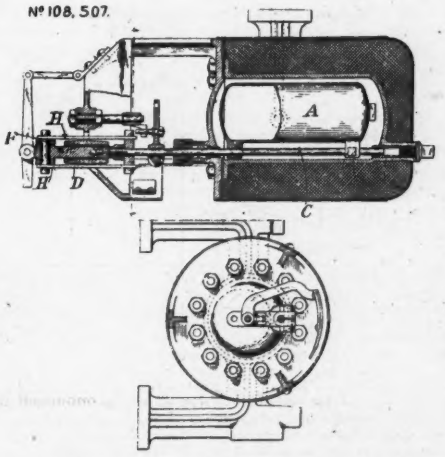


ring in two or more sections B C D, according to the number of the wedges, and these are so cut or shaped as to adapt themselves to the wedge-shaped ring. Where the sections meet the thick end of the wedges, spiral or other suitable springs J are provided, by which the sections can be expanded, so as always to ensure a tight fit to the internal bore or diameter of the cylinder. In the case of rod or such-like packings, the form of the packing is reversed, that is to say, the wedge-shaped ring is on the outside and the sections on the inside.—*August 16th*, 1917.

STEAM GENERATORS.

108,507 (11,030 of 1916). August 4th, 1916.—FEED WATER APPARATUS, Thomas Clarkson, Woodlands, Galleywood, Chelmsford.

This invention applies to float controlled feed apparatus, such as is used for steam generators for self-propelled vehicles. It is primarily concerned with an improved construction of the float spindle, and the operating mechanism which imparts to the float a reciprocating motion. The spindle C of the float A is operated by a rod or plunger F in axial alignment with the float spindle, the adjacent ends of the spindle and the rod being formed of hardened surfaces, one preferably plane and the other convex, the two hardened surfaces being in contact. The hardened

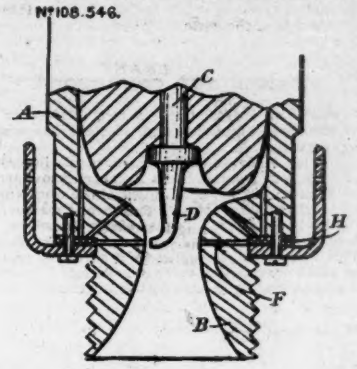


surfaces and the adjacent portions of the float spindle and rod are enclosed in a sleeve D in which they can slide freely, and outside this sleeve links H are provided connected to the rod and to a sleeve through which the float spindle passes freely. One end of this sleeve is arranged to bear against a collar or abutment on the spindle. Through some convenient mechanism a slow reciprocating motion is imparted to the rod, and transmitted by it to the float spindle. Fig. 1 is a plan partly in section of the apparatus, and Fig. 2 an end view.—*August 7th*, 1917.

INTERNAL COMBUSTION ENGINES.

108,546 (11,787 of 1916.) August 19th, 1916.—SPARKING PLUG, Herbert George Longford and others, 240-242, Bradford-street, Birmingham.

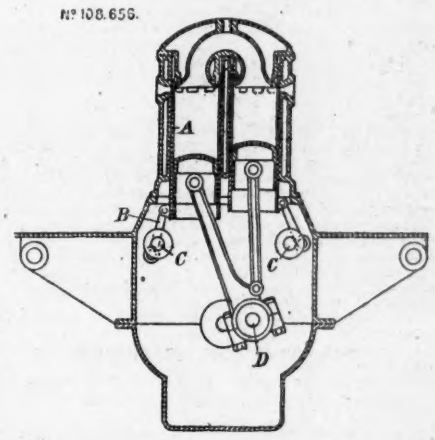
In this sparking plug an air conduit is provided in the shell through which air passes by virtue of the operation of the engine. The air conduit or conduits remain permanently open, being so constructed as to provide that the compression and explosion pressures are not appreciably impaired. The casing A of the plug is constructed of external form, substantially resembling that of existing plugs, having a reduced externally threaded base part, and a shoulder between the threaded periphery of such base part and the larger body portion of the shell. Internally the annular surface of the base part converges from its outer extremity to a point substantially level with the external shoulder, at which point it commences to diverge pronouncedly until it adjoins the inner surface of the shell part of the plug, the axial thickness of the metal at the juncture of the shell part of the plug with the boss part being substantially equal to the trans-



verse thickness at the level of the shoulder. The central electrode C may at its extreme end D be bent at an angle to project towards that part of the internal face of the boss-like part occurring at its region of minimum diameter. In alignment with the laterally diverted extremity of the central electrode a perforation F is formed in the wall of the boss or base portion, said perforation advantageously terminating at or in the vicinity of the external shoulder. The channel or channels is or are constricted externally by a washer H, composed, for instance, of wire gauze.—*August 16th*, 1917.

108,656 (5964 of 1917). April 27th, 1917.—TWIN CYLINDER ENGINE, Thomas Abney Napier Leadbetter, "Arcan," Bower-road, Hale, Cheshire, and others.

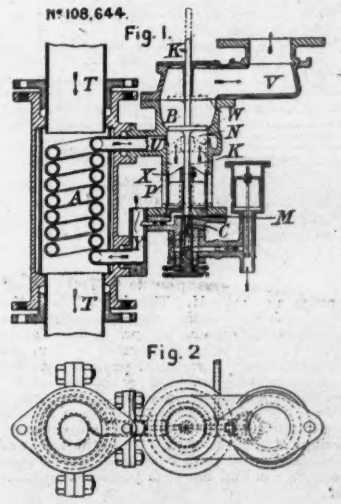
This is a four-stroke engine in which each engine unit comprises twin cylinders communicating at the top or head in an explosion chamber common to both cylinders. The inlet and exhaust of the gases are controlled by means of sleeve valves A mounted between the pistons and the cylinders, and operated



either by a reciprocating or rotary movement, such movement being effected by means of links and disc cranks B C, chains or excentrics, from an auxiliary shaft driven from the crank shaft. The twin pistons of each unit are coupled up to a crank pin D common to both pistons. The engine may be arranged in any suitable form, either in V-pattern having two units working on a common crank pin, or a series of engine units may be arranged in radial form working on a crank pin common to the series of units.—*August 16th*, 1917.

108,644 (3088 of 1917). March 2nd, 1917.—CARBURETTER, Frank Smith, Huddersfield-road, Elland, Yorkshire, and another.

This is a carburetting device in which an exhaust heated vaporising coil A is combined with a suction controlled valve B,



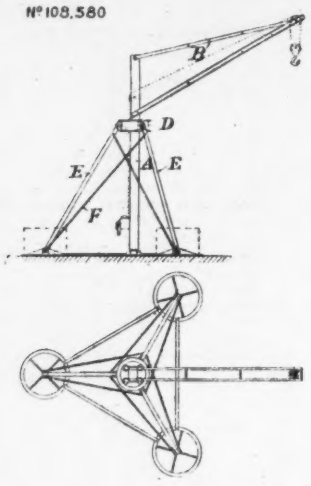
which governs the flow of the fuel. The carburetting chamber N has a shaped upper portion, below which are the vapour fuel ports U and the additional air ports P. These ports are controlled by a throttling device X on the valve rod K, and the latter has a shoulder M for shutting off the fuel supply when the engine is stopped. The device is shown in Figs. 1 and 2. The hydro-

carbon, after leaving the valve C, gravitates through a pipe connection to a coiled tube A placed in the exhaust pipe T where it is vaporised. The resultant vapour along with the supply of air which, when the engine is running idle, or for slow running, enters through the opening Y, is drawn out of this heated coil by the suction through the port U into the carburetter immediately below the disc B, which is lifted slightly to allow of the passage of the mixture through the port W to the induction pipe V. Any acceleration of speed by the opening of the ordinary throttle usually placed in the induction pipe correspondingly increases the suction, which also increases the lift of the valve C, permitting a greater flow of hydrocarbon to the vaporiser, the additional proportion of air for which is provided by the automatic opening of the ports P by the sleeve X.—*August 16th*, 1917.

CRANES AND CONVEYORS.

108,580 (14,199 of 1916). October 6th, 1916.—JIB CRANES, Herbert Morris, Limited, and another, Empress Works, Loughborough.

This invention is for an easily transportable jib crane. The jib B is mounted on a vertical post A in such a manner that the compression boom of the jib is attached to the vertical post at a suitable height to allow the tripod or shear-leg construction to be put entirely below it. Immediately below the point of attachment of the compression boom a bearing is formed on the post. This bearing is journalled in a surrounding horizontal ring D to which are attached three or more legs E spaced around the ring and extending in an inclined direction to the ground

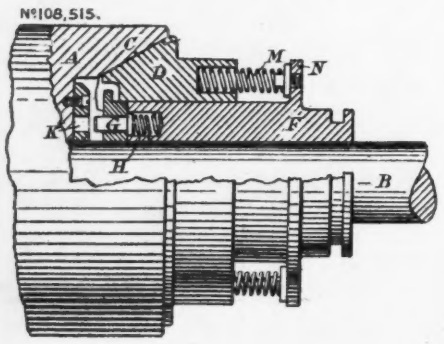


level, where they are fixed or pivoted to base plates or spikes. To prevent the horizontal ring rocking out of horizontal there is attached to the base of each leg a pair of guys F, the other ends of which guys are attached one to each of the adjacent legs by means of eyes at the top of the legs. Alternatively, the guys may pass through the eyes at the top of the legs and bend down again to the base of the next adjacent leg in order. The vertical post is pivoted in a footstep bearing at the ground level. This bearing may be tied to the leg base plates by horizontal members to retain it in correct position. Alternatively, the bearing and the base plates may be spiked into the ground with the same object.—*August 16th*, 1917.

TRANSMISSION OF POWER.

108,515 (11,108 of 1916). August 7th, 1916.—FRICTION CLUTCHES, Harry Benjamin Vogel, Angle House, East Molesey.

In the clutch illustrated, A is an element to be clutched to a shaft B, and the frictional clutching action is given by co-operating internal and external conical surfaces. The internal surface C is shown on the element A and the external surface on a sliding sleeve D. The positive clutch carrying member is a sleeve F feather keyed on the shaft and having a series of recesses in which studs G and the springs H behind them are housed, the studs being projected through a plate such as J on the front end of the sleeve F. To receive the studs G the element A is provided with a plate having a corresponding

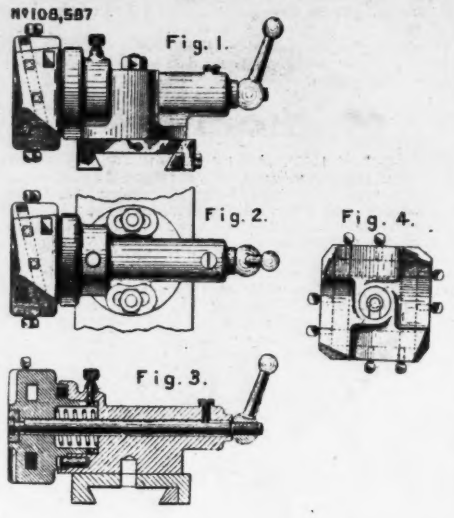


series of recesses or holes K. The sleeve D is feather keyed so as to rotate with the positive clutch member F, and may be urged into operative position by springs M which bear against a collar N. In use, the friction clutch is brought into action by sliding the sleeve F carrying the positive members and the positive members G are projected by the springs H, but do not come into operation until the sleeve F is moved further in toward the element to be clutched than is necessary for permitting engagement of the frictional clutch under the action of the springs M. There is thus an initial frictional clutching action, and, finally, the positive studs G find their way into the holes or recesses K and establish positive connection.—*August 7th*, 1917.

MACHINE TOOLS AND SHOP APPLIANCES.

108,587 (14,558 of 1916). October 13th, 1916.—TURRET LATHES, Charles Birch, Upper and Lower Brook-street, Walsall, and another.

This invention is for an improved turret mounting which permits rapid removal and replacement of a turret, and an arrangement of the turret to give complete accessibility to the tool in operation and to give the operator an unobstructed view of the tool. The inventors employ a turret mounting in which a horizontal holder or socket part receives a hollow spigot portion of the turret and a spring between the holder and the turret urges the latter forward to clear a peg and hole positioning device between the two parts. The turret when thus projected

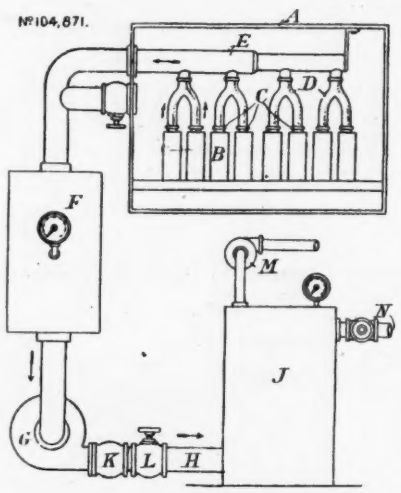


forwardly may be rotated to bring the different tools carried by it into operative position. The endwise movement of the turret is controlled by means of a sliding rod with a removable washer at one end and a handle nut at the other. The handle nut when unscrewed permits the spring to move the turret, and when screwed up draws back the turret against the spring. By means of the removable washer the turret can be bodily removed in a very ready manner when desired. The construction of the turret will be readily followed from the illustrations Figs. 1–4.—*August 16th*, 1917.

SHIPS AND BOATS.

104,871 (3563 of 1917). March 10th, 1917.—VENTILATION OF SUBMARINES, John Merritt Clark, Shore-road, Whitestone, Long Island, U.S.A.

This is an apparatus for withdrawing obnoxious gases from secondary batteries, and from a housing in which they are situated. It comprises a tube connection to the batteries and a valve-controlled passage from the housing to the tube connection, a tank into which gases from the batteries, and when desired from the housing, are received, a fan connected to the tank by a tube and also connected to a second tank in such a manner that the gases can be drawn from one tank to the other and a controllable outlet from the second tank to a tube which may lead to the atmosphere or to an engine in which the gases can be burnt. The drawing shows one arrangement of apparatus in which the battery room of a submarine or other craft is

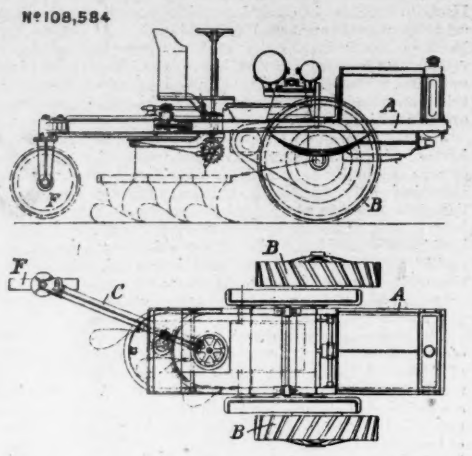


designated by A, the battery cells at B, provided as shown at C, with the usual gas checks, having gas-tight connection with flexible tubes D, communicating with a manifold E, leading out of the battery room, into a gas reservoir F, connected by a pipe to a pump G, whose outlet communicates by pipe H with a gas storage tank J, the pipe being provided with a check valve K and a stop valve L. An exhaust pump M is connected with the storage tank, to remove all air therefrom before the hydrogen or other dangerous gases are allowed to enter. An outlet connection as at N is provided to convey the stored gas either to the explosion chamber of an internal combustion engine as fuel, or the stored gas may be expelled outboard into the air through a suitable outlet when the submarine is at the water surface.—*August 16th*, 1917.

MOTOR CARS AND ROAD TRAFFIC.

108,584 (14,456 of 1916). October 11th, 1916.—TRACTOR FOR PLOUGHS, Francis Mark Waller, 11, Brunswick-terrace, Stafford.

This invention consists of an improved method of steering. The tractor has three wheels, two of which are the driving wheels B and are arranged in parallel relation to one another side by side at a suitable distance apart, and the third of which, F, is arranged behind the driving wheels and is capable of being offset on either side of the longitudinal centre line of the machine to the extent that will bring it clear of the width of ground traversed by the plough. The frame A carrying the driving wheels is pivoted to the frame C carrying the rear wheel at a suitable position between the two sets of wheels and at a suitable position to the rear of the axis of the driving wheels. Suitable mechanism controlled by the usual steering wheel is provided to enable relative movement to be imparted to the frames carrying the two sets of wheels for the purpose of guiding or steering the



tractor. It is claimed that a tractor as described is virtually steered and guided by the front driving wheels.—*August 16th*, 1917.

THE ACQUISITION OF PATENT RIGHTS.

The following list of British Patents, which have been granted in favour of residents of Germany, Austria, or Hungary, is furnished in view of the new Patents Acts, which empower the Board of Trade to confer upon British subjects the right to manufacture under enemy patents—which right when acquired can be retained after the war—and has been specially compiled for THE ENGINEER *by Lewis Wm. Goold, Chartered Patent Agent, 5, Corporation-street, Birmingham. It is desirable in the first instance to obtain the latest particulars upon the Patents Register. If any patent listed has been assigned to, or is the property of, a non-enemy proprietor, the law does not apply.*

On each of two of the patents given below £26 *and on each of the remainder* £18 *have been paid in renewal fees.*

No. 30,091/10.—Cements; bituminous compositions. A substance for adding to cement to render it waterproof consists of ground bituminous shale treated with hydrochloric acid, and, after the carbonic acid has escaped, heated for about three hours with steam at about four atmospheres. The mass, while still hot, is mixed with gas tar mineral oil or the like and dried at 100 deg. Cent. The substance has the property of forming an emulsion with wet cement, and of emulsifying a further quantity of tarry or oily substances. In one example, 75 kilos. of hydrochloric acid are added to 250 kilos. of ground shale, and to the plastic mass 15 per cent. of tar and 15 per cent. of oil are added. The dried product is added to Portland cement in the proportion of one part of product to eight parts of cement. Deutsche Rekord Cement Werke, J. Krumpelmann and Co., and Krumpelmann, J., Germany.

No. 30,092/10.—Rolling metals. In rolling mills having a pressure device for moving the mandril rod, a liquid brake is employed consisting of a rod working in a cylinder connected by holes with a tank containing a liquid such as water, glycerine, &c. A pipe coil may be employed for cooling purposes. The rod has a narrow portion which, towards the end of the stroke, enters a reduced portion of the cylinder, and at this point the braking is a maximum. A safety stop may be employed in conjunction with the liquid brake. Mannesmannrohren-Werke, Germany. Dated March 9th, 1910.

No. 30,212/10.—Railway vehicles; couplings, operating from engine; couplings, automatic. The last vehicle of a train can be uncoupled from the locomotive by means of pneumatic pressure or vacuum. The train pipe is made up of sections on each vehicle. When the vehicles are brought together in coupling, the tapered pipe end on one vehicle enters the casing on the other, and moves overlapping spring-pressed plates radially outwards. One of these plates is connected to a slide which normally closes the end of the train pipe, and, as the plate is pressed outwards by the entering end of another section, the slide is opened, and at the same time a passage between the train pipe and the uncoupling cylinder is closed by a valve. Lanzdorf, A., Vienna. Dated December 29th, 1909.

No. 30,389/10.—Joints for tubes, &c.; overlap joints. A joint between a readily interchangeable hollow body and a conduit is made by a packing washer placed around the conduit and resting on plates which can rock in the manner of a cardan joint so that a tight junction is formed even when the hollow body bears obliquely on the packing. Dragerwerk, H., and B. Drager, Germany. Dated January 29th, 1910.

No. 64/12.—Cartridge loading machines. Relates to machines in which the cartridge cases are conveyed step by step by a reciprocating slide. According to this invention the cases are conveyed along fixed slots in rows, one row at a time, by a reciprocating slide provided with rows of spring grippers, and means are provided for discharging the projectiles where cases are missing and for discharging the loaded cartridges into three lots according to their heights. Wetzler, B., Vienna. Dated March 14th, 1911.

No. 65/12.—Cartridge loading machines. Relates to powder loading and checking devices, and consists (1) in a combination of tubes for guiding the powder from the measuring hopper and holding down the cartridge case; and (2) in a device for discharging incorrectly filled cases. Wetzler, B., Vienna. Dated March 14th, 1911.

No. 66/12.—Cartridge loading machines. Relates to bulleting devices, and consists in conveying bullets which fall from a row of delivery hoppers into a row of retaining hoppers vertically, below the delivery hoppers, and then pushing them into a row of cartridge cases. Wetzler, B., Vienna. Dated March 14th, 1911.

No. 67/12.—Cartridge loading machines. Consists in a machine comprising means for feeding cartridge cases and projectiles, means for conveying rows of cartridge cases step by step under the various loading devices by a reciprocating slide, and finally discharging the loaded cartridges, powder loading and checking devices, and projectile inserting devices. Wetzler, B., Vienna. Dated March 14th, 1911.

No. 109/12.—Rolling metals. Motor operated gear for adjusting the horizontal rolls and the vertical rolls of a universal mill is arranged so that each of the two sets of rolls can be independently adjusted. A seperate motor may be used for each adjustment, or a single motor may be used in conjunction with two clutches and separate trains of gearing. Selge, F., and Deutsch-Luxemburgische Bergwerks-Hutten-Akt.-Ges., Luxemburg. Dated May 19th, 1911.

THE SHRINKAGE ALLOWANCE FOR LOCOMOTIVE TIRES.

By E. L. AHRONS, M.I. Mech. E.

IN comparing the amounts allowed for the shrinkage of tires on different railways, very considerable discrepancies exist, of which a number of examples may be cited. During a period down to comparatively recently the following allowances were standard on one large English main line for tires 2½in. thick on tread when new, the steel having an ultimate tensile strength of 35–40 tons per square inch.

Diameter on tread.	Diameter of wheel centre.	Shrinkage allowance.	Proportion Shrinkage allowance / Dia. of wheel centre
ft. in.	ft. in.	inch.	
8 0	7 7	.0781	1 in 1165
7 0	6 7	.0719	1 in 1100
6 6	6 1	.0687	1 in 1062
6 0	5 7	.0656	1 in 1021
5 6	5 1	.0625	1 in 976
5 0	4 7	.0594	1 in 926
4 6	4 1	.0562	1 in 871
4 0	3 7	.0531	1 in 810

In the above it will be noted that the proportional number increases as the diameter of the wheel decreases, and it may be compared with the figures given below for present American practice, in which the proportional number increases with the diameter of the wheel centre. These shrinkage allowances are those adopted by the American Master Mechanics' Association :—

Diameter of wheel centre.	Bore of tire.	Shrinkage.	Proportion, Shrinkage allowance / Dia. of wheel centre
inches.	inches.	inches.	
90	89.8750	.1250	1 in 720
86	85.8816	.1184	1 in 727
82	81.8881	.1119	1 in 733
78	77.8947	.1053	1 in 741
74	73.9012	.0988	1 in 749
72	71.9045	.0955	1 in 754
70	69.9078	.0922	1 in 759
66	65.9144	.0856	1 in 771
62	61.9209	.0791	1 in 784
56	55.9308	.0692	1 in 810
50	49.9406	.0594	1 in 843
44	43.9505	.0495	1 in 889
38	37.9603	.0397	1 in 957

On the Lancashire and Yorkshire Railway, Mr. George Hughes ("Proc." Inst. Mech. Engineers, 1909) stated that, prior to the end of 1908, the practice with regard to shrinkage was not quite proportionate to the diameter. Too much shrinkage was allowed on small tires, and probably not enough on large tires. The shrinkage was revised to the standard figure of 1 in 750 of the diameter of the wheel centre for all sizes.

The tires of the Lancashire and Yorkshire alluded to were 3in. thick, and the steel had a tensile strength of 42 to 48 tons per square inch. The wheel centres were of cast steel. In the course of the discussion on the paper by Mr. Hughes, Mr. Fowler, of the Midland Railway, said he thought the shrinkage allowance of 1 in 750 was somewhat high compared with that generally in use. The shrinkage of the Midland tires was 1 in 1100, and 1 in 1200 was not unusual. In the diagram —Fig. 1—the graphs give the actual shrinkages for wheel centres of different diameters as follows :—

A A. Large English railway—Table I.
B B. American Master Mechanics' Association standard.
C C. Lancashire and Yorkshire Railway,

and in Fig. 2 the abscissæ show the proportional shrinkages 1 in n, the values of n being plotted, instead of the actual shrinkages of Fig. 1. This diagram shows the differences of shrinkage allowance by various locomotive engineers in a very marked degree.

In THE ENGINEER of April 7th, 1916, some particulars were given relative to the most recent practice adopted by Mr. Gresley on the Great Northern Railway, the system being to measure the outer circumference of the shrunk-on tire by means of a steel tape. This method, which is more scientific than those hitherto adopted, was introduced as a result of the breakage of two express engine tires, the failure of which was ascribed to over-strain of the material of the tire during the shrinking on.

The standard practice of the Great Northern was to allow a shrinkage of 1 in 800. Stress-strain diagrams, made from tests of class C—British standard —tire steel, of 50 to 55 tons ultimate tensile strength, showed that the elastic limit was reached with an extension of about .2 per cent. at 26.5 tons per square inch. Therefore an extension of .1 per cent., or 1 in 1000, results in a stress on the material of the tire of 13.25 tons per square inch. The modulus of elasticity of this tire steel will therefore be 13,250.

The diameter of the wheel centre was 74in., and of the tread of the tire, after shrinkage, where the measurement was taken, was 80in., the tire being 3in. thick. It was found that the outside perimeter had extended .232in. after shrinking on, with an allowance of 1 in 800 on the inside, *i.e.*, on the diameter of the wheel centre. The outer circumference, after shrinking, being 251.33in., the original length of the circumference was therefore 251.098in., and the strain $e = \frac{.232}{251.098}$. The stress in the outer fibre of the tire $= 13{,}250\, e = 12.242$ tons per square inch.

Treating the tire as a ring of rectangular section, and using Lamé's method of calculating the stresses in thick cylinders, and if

P_2 = hoop stress on the outer fibre (= 12.242),
P_1 = hoop stress on the inner fibre,
Q_2 = radial compressive stress on the outer fibre,
Q_1 = radial compressive stress on the inner fibre of the tire at the surface of junction between tire and wheel centre,

the relation between the hoop tension P and the radial stress Q at all points within the tire is $P_2 - Q_2 = P_1 - Q_1 =$ constant, and since there is no radial pressure on the outside of the tire $Q_2 = 0$, and therefore $P_1 - Q_1 = P_2 = 12.242$ tons per square inch.

On the inner fibre of the tire the usual form of Lamé's expression gives—

$$P_1 = Q_1 \left\{ \frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} \right\} \quad . \quad . \quad . \quad (1)$$

in which R_2 and R_1 are the outer and the inner radii of the tire, and P_1 is the apparent hoop tension, neglecting the effect of lateral contraction (Poisson's ratio).

Taking the effect of lateral contraction into account, the stress equivalent to the greatest strain is—

$$P_1 = Q_1 \left\{ \frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \frac{1}{m} \right\} \quad . \quad (2)$$

in which m may be taken as 3.5, an average value for steel.

The thickness of the tire is nominally 3in., but as the outside tread is turned to 80in. diameter ($R_2 = 40$), the actual thickness is very slightly greater, since R_1 is slightly less than 37in. after shrinking, by an amount depending upon the contraction of the wheel centre.

Neglecting for the moment the contraction of the wheel centre, the value of P_1, the stress on the inner fibre of the tire, becomes from equation (2) $13.138\, Q_1$, and since from (1) $Q_1 = 12.242 - P_1$, the value of P_1 becomes 13.25 tons per square inch.

The strain on the inside layer of the tire, or the stress—13.25 tons—divided by the modulus of elasticity—13,250—is .001, *i.e.*, the actual or terminal shrinkage is 1 in 1000.

If the wheel centre be supposed to have contracted .02in. in the diameter the equation (2) gives $P_1 = 13.094\, Q_1$, from which $P_1 = 13.255$ tons per square inch. The effect of the contraction on the stress in the tire may, for ordinary cast steel wheel centres, be neglected.

The difference between the effective or real shrinkage allowance of the tire and the nominal allowance is of interest. The tire was bored with a nominal shrinkage allowance of 1/800, or .0925in. smaller than the diameter of the wheel centre, so that its bore, before being put on, would be 73.9075in. The real shrinkage when on the wheel has been found to be 1/1000, and the difference between the real and the nominal shrinkages is .0185in., which may be taken as the actual contraction of the 74in. wheel centre.

There is room for experimental investigation into the question of the amounts of the contraction of wheel centres of different diameters. The maximum stress on the inner fibre of the tire is from the above 13.25 tons per square inch, which is half the elastic limit of the steel, and does not supply the reason for the breakage of such tires as Mr. Gresley mentioned. It may, however, happen that an occasional tire is gauged too tightly, in which case the nominal shrinkage may be considerably in excess of the 1/800 allowance. The steps taken by Mr. Gresley to provide against this contingency by measuring the outside circumference of the tires with a steel tape were fully described in THE ENGINEER for April 7th, 1916.

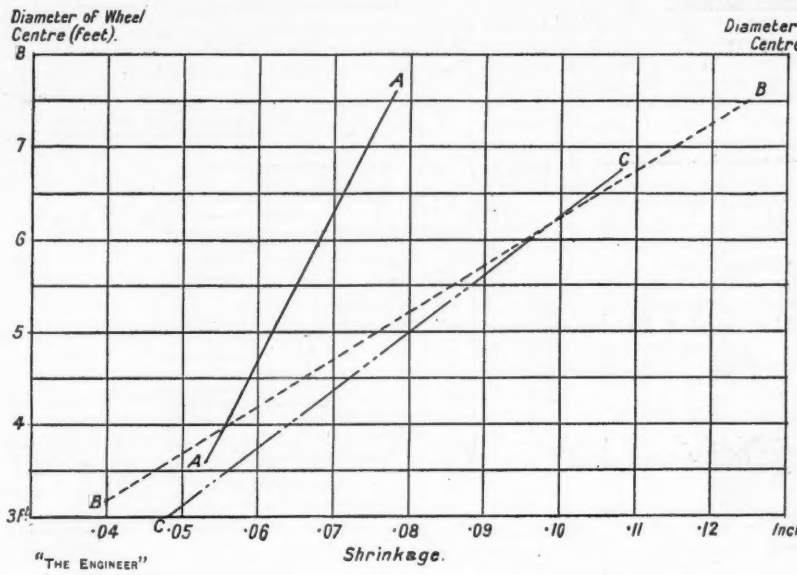


Fig. 1

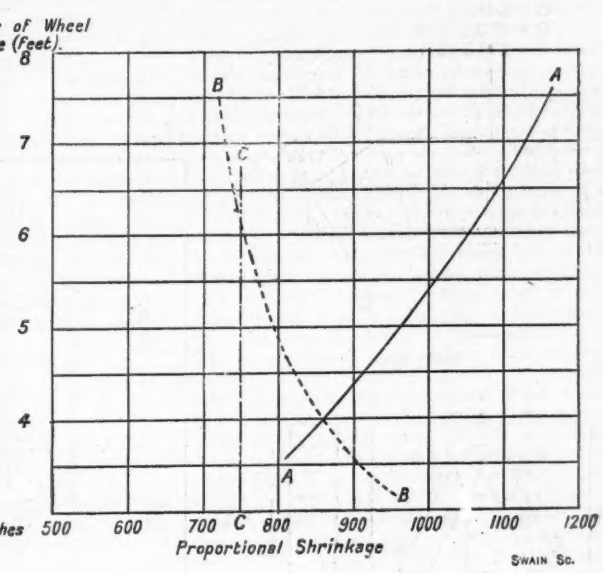


Fig. 2

SHRINKAGE OF LOCOMOTIVE TIRES

The above stress in the tire is a static stress, and it is probably the case that the additional dynamic loads, which are being constantly repeated and reversed in direction, caused by the flange blows between tires and rails, more especially on curves and crossings, and also by the vertical unbalanced centrifugal force of the balance-weights, may in time produce the results of repeated stress, and ultimately cause fracture of an apparently sound tire, which has been shrunk on under a maximum hoop tension considerably less than the ordinary elastic limit of the material. If this be one explanation of such fractures as Mr. Gresley mentions, it may be safer to reduce the nominal shrinkage allowance for express engines to not less than 1/1000 of the diameter of the wheel centre. With regard to the dynamic effect of the balance weights the writer suggests that for modern heavy express engines a smaller proportion of the reciprocating masses be balanced. The resisting moment of such engines to oscillation is very much greater than was formerly the case in smaller engines, and therefore they will run with proportionately equal safety and steadiness with less of the reciprocating masses balanced. The result would be less variation of rail load, or so-called "hammer-blow" effect, and the additional stresses on the tires would be reduced.

THE MANUFACTURE OF HARDENED THREAD GAUGES.

By G. DOORAKKERS.

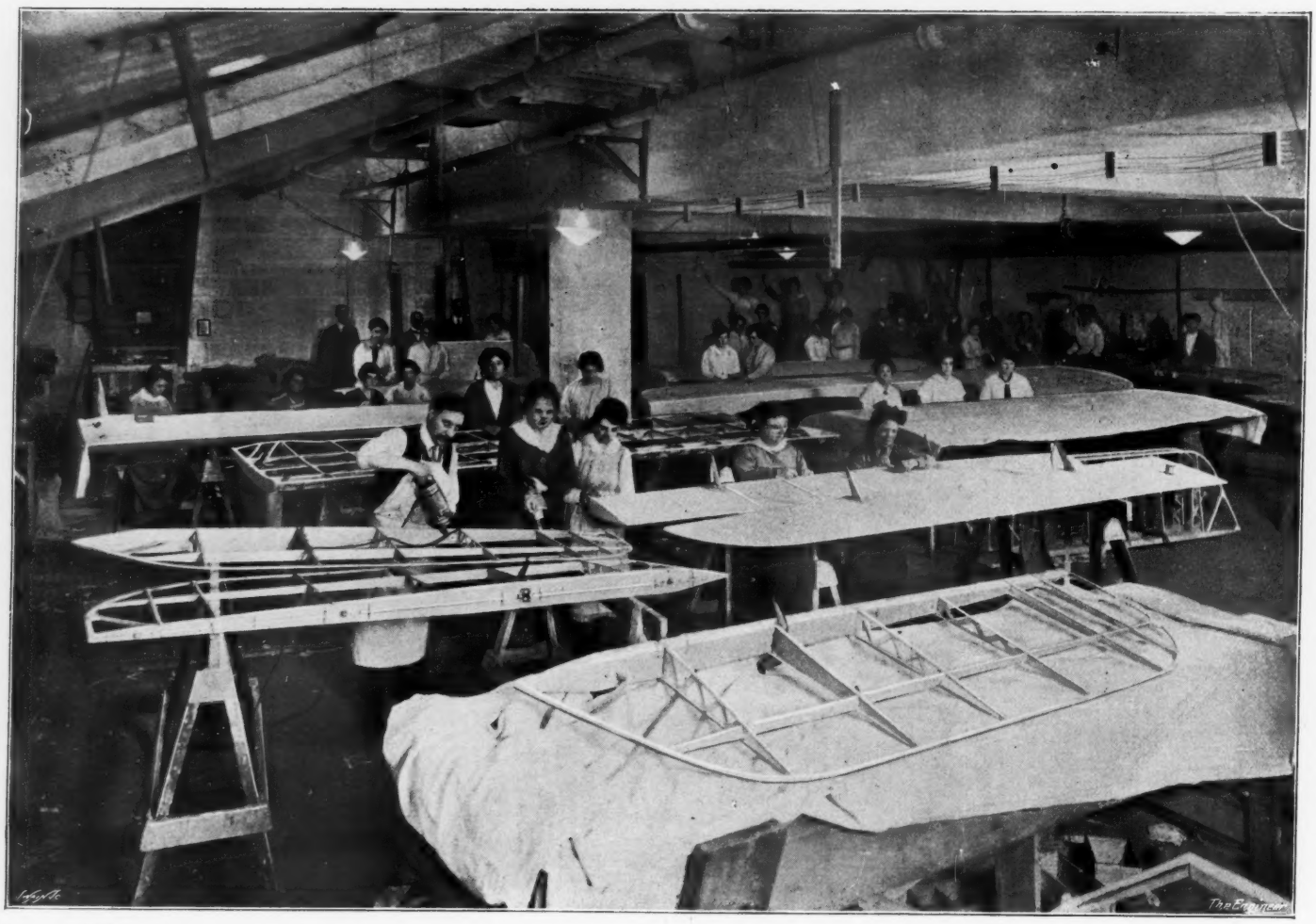
No. I.

VERY little practical information has been published concerning the manufacture of hardened thread gauges. The available data usually does no more than inform us how to determine the correct thread, and makes little attempt to show us how to obtain it. The optical way of checking the gauge is, of course, an excellent one, but in the following notes I shall only give a mechanical way of checking, which has, in all respects, compared very favourably with the optical way.

In settling the lay out for the manufacture, the first item of importance is what machine to employ. The lathe is most commonly used, but in some cases thread milling machines are used with fairly good results. For the finishing of a reliable screw gauge, however, a lathe is hard to beat. It is, however,

AN ENGLISH AEROPLA

BUILDING-UP WINGS ETC.



COVERING THE WINGS

ASSEMBLING WING FRAMES

BUILDING-UP WING FRAMEWORK